MONTANA

cooperative elk-logging study

SK
417
.M85
1974

ANNUAL PROGRESS REPORT – August, 1975

Bureau of Land Management
Library
Denver Service Center

MONTANA

COOPERATIVE ELK-LOGGING STUDY

Progress Report for the Period

January 1-December 31, 1974

COOPERATING AGENCIES

Region I, U. S. Forest Service
Intermountain Forest and
  Range Experiment Station
Montana Department of Fish and Game
Bureau of Land Management
School of Forestry, University of Montana

STEERING COMMITTEE

Roger Bumstead, Chairman
Ralph Klawitter

Wynn G. Freeman
Don McIntosh
Robert F. Wambach

Submitted by Research Committee:

Eugene O. Allen, F & G, Chairman
Joseph V. Basile, USFS
Richard Ellison, BLM
Reuel G. Janson, F & G
Terry N. Lonner, F & G
L. Jack Lyon, USFS
Floyd Pond, USFS
Robert Ream, U of M

August, 1975

Bureau of Land Management
Library
Denver Service Center

TABLE OF CONTENTS

Page

ABSTRACTS v

MANAGEMENT RECOMMENDATIONS. x

I Problem Analysis and Coordination 1

II-A. Burdette Creek-Deer Creek Study. 7

Procedure B-1 Pellet count survey. 7
Procedures B-2, B-3A and B-3b, Elk Harvest, Distribution and food habits. 14

II-B. Long Tom Creek Study 25

II-C. Sapphire Divide Study. 73

II-D. Chamberlain Creek Study. . . . . 79 BLM

III-A.1 Upper Ruby Road Closure Study. 119

III-A.2 Judith Road Closure Study. 119

III-B. Elk use of Disturbed Areas 121

IV. Spotted Bear Study 133

APPENDIX 141

Abstracts of M.S. and Ph.D Theses for jobs completed associated with the elk-logging study. 143

MONTANA COOPERATIVE ELK-LOGGING STUDY

January - December 1974

ABSTRACTS

JOB I

PROBLEM ANALYSIS AND COORDINATION

During the year 10 meetings involving one or more members of the research committee were necessary to plan and coordinate project activities. A total of 19 presentations were made by research committee members to advance public awareness and understanding of the elk-logging study. Five management recommendations were finalized and distributed. A bibliography of 276 citations on elk and logging was adapted to a computerized documentation system. A number of publications were completed. Other activities during the period are reported.

JOB II-A

BURDETTE CREEK-DEER CREEK STUDY

Procedure B.1. Pellet Count Survey

Distribution of elk, as indicated by pellet groups, showed a continuing decline in Deer Creek during 1974. Changes in elk use of other drainages, however, were associated with winter weather rather than timber-sale activities. The winter of 1973-74 was much more severe than 1972-73 and elk pellets confirmed a shift back to the winter ranges below 5,000 feet.

Activity summaries and elk distributions for the first five years of study are presented. The timber sale in Deer Creek has been completed and the road system was closed in October 1974. Thus, the final phases of study will be initiated with the 1975 pellet survey.

Procedures B-2, B-3a and B-3b. Elk harvest, distribution and food habits.

The 1974 elk hunting regulations in the study area vicinity were similar to the 1973 regulations except that there was an early bull season September 15-19 in 1974. The general elk season was open October 20-31 for either sex elk, and through November 17 for antlered bulls.

The total number of hunters checked through the Lolo Creek, Fish Creek and Petty Creek stations was 4,892 in 1974, compared to 4,541 in 1973. The total number of elk checked was 94, compared to 126 in 1973. Mild, dry weather during the 1974 season was the main cause of the lower harvest.

The time distribution of the harvest was 16 elk during the early bull season, 77 during the either sex season, and one during the late bull season. The sex-age composition of the harvest was 50 bulls, 30 cows, and 14 calves.

Seven elk were killed in the study area proper (the area bounded by Fish Creek on the west, Petty Creek on the east, the Wagon Mountain road on the south and Beaver Slough Creek and the West Fork of Petty Creek on the north) in 1974. This compares with 14 in 1973, 5 in 1972, 19 in 1971, and 33 in 1970. Differences in season length, weather and resident elk populations are the reasons for harvest variations. Winter population (about 150 by aerial count) apparently does not vary much. However, a count of 201 was obtained May 1, 1975.

Only one elk was killed in Deer Creek in 1974, and it was on the west side of Deer Peak at the head of the drainage. Four elk were killed in Deer Creek in 1970 as timber harvest activity was just beginning.

Tom Lemke continued radio tracking and observation of marked elk during the year. Thirteen radios were operating in early summer, and eight during December, 1974. One marked elk was reported killed during the 1974 season. In late spring marked animals dispersed from their winter range in Burdette, Lupine and Wig Creeks. Most moved westward to the high country near the Idaho Divide. During the early hunting season, half of the radioed elk made long, rapid movements, and half stayed in their general summer range. Radioed elk moved back to the winter range in the second week in December.

Information concerning seasonal elk use of habitat types and effects of roading, logging and hunting from Joseph Bohne's thesis were presented.

JOB II-B

LONG TOM CREEK STUDY

Elk use of the Long Tom Creek study area was evaluated on a seasonal basis from June through August (summer season), September through early October (rutting season), and early October through late October-early November (1st third of hunting season). The distribution of elk use within the study area as defined by 16 subdivided areas for these seasonal categories was quite varied between areas for 1972 through 1974. Statistical analysis showed the overall variation of elk use between years and within subdivided areas between years not to be significant during the summer and breeding season, although there were some significant differences of elk use within individual areas between years. Measurement of elk distribution during the 1st third of the hunting season for all 3 years was so varied that its interpretation was highly questionable. The distribution of elk use for the fall of 1971-1973 showed significant variation between areas and between years. A significant seasonal shift in elk use between the summer and rutting seasons for all 3 years occurred in no more than 5 and not less than 3 of the subdivided areas.

Preliminary findings on elk-habitat use relationships showed that during the summer months elk had a strong affinity for wet sedge parks and broken parks that were interspersed and/or immediately bordered by the alpine fir/*Calamagrostis canadensis* forest habitat type. The elk use that occurred in clearcuts during this season was mostly in and immediately surrounding cut-through natural dry and mesic parks. A dramatic shift of elk use from wet sedge parks and broken parks during the summer to dry parks during the rut occurred all 3 years. This was also consistent with elk use measurements for the entire fall (September through November), although a difference of elk use in subtypes occurred.

Elk use was evaluated with respect to 3 physiographic features - wetness degree or amount of surface water, topography, and sight distance. Characteristics of 213 elk bedding sites was also discussed.

A brief discussion of results from radio-telemetry and time-lapse photography for the 1974 field season was presented.

A detailed presentation of elk-cattle distribution and interspecific relationships was made. Interspecific association measurements between elk and cattle showed a significant negative response of elk towards cattle during the summers of 1973 and 1974. This negative interaction resulted in a displacement of elk by cattle that appeared to be initially caused by social intolerance of elk towards cattle.

JOB II-C

SAPPHIRE DIVIDE STUDY

All radio marked elk were periodically monitored during the report period. Some unusual elk movements are described. A Ph.D. thesis was completed titled: Summer and fall habitat selection and use by a Western Montana Elk Herd.

The summary is included.

JOB II-D

CHAMBERLAIN CREEK STUDY

All field data collection concerning elk use of their undisturbed habitat in Chamberlain Creek has been completed.

Initial analysis of the data has been made from combinations of summary tables, simple statistical correlations, and stepwise multiple regression correlations.

Elk in Chamberlain Creek show preferences for different Timber Habitat Types described by Pfister et al. 1974. Each Timber Habitat Type is rated by a ratio of elk use to availability in the study area.

The area is stratified by these Timber Habitat Types. Vegetative composition summaries are compared between Timber Habitat Types and simple correlations were made concerning elk use in each Timber Habitat Type in relation to physiographic variables. Simple correlations were also made in relation to adjoining Timber Habitat Types to test the effect of interspersions.

Regression correlations were derived from physiographic variables and interspersion variables within and between Habitat Types.

Results of this analysis indicate that elk have strong affinity for cool-moist areas on many of the summer range habitat types. These are mostly in the Alpine-fir zones.

This tendency is not as strong in the Douglas-fir zones, where elk presumably make most of their use during cooler seasons.

Variables affecting elk preference most within Timber Habitat Types appear to be slope, aspect, temperature, moisture and density of tree stems.

The variation in elk use between Timber Habitat Types is most likely related to the above variables plus significant differences in vegetative compositions between Timber Habitat Types.

JOBS III - A.1 AND III - A.2

JUDITH AND RUBY ROAD CLOSURE STUDIES

All field work has been completed; the final report is in preparation.

JOB III - B

ELK USE OF DISTURBED AREAS

A new analysis of 1974 data is presented along with a graphic model set for deer and another set for elk. These models explain, respectively, 71 and 40 percent of the variation in animal use of clearcuts with four variables:

Acres: 60 a. openings are preferred by deer; elk preference ranges from 10-20 a. when the uncut forest has 2.0-2.5 feet of down timber to nearly 100 a. where the uncut understory is free of down timber.

Slash: For both deer and elk, use of any opening will be reduced at least 50 percent by 1.5-2.0 feet of slash.

Vegetation: Deer use increases as vegetation height in the cut increased to 3 feet. Additional cover does not increase deer use. Elk use, on the other hand, continues to increase as vegetation height increases in large openings. In small openings vegetation height has no influence on elk use.

Dead and down: Where dead and down timber in the uncut exceeds 2.0 feet, deer will not be present. Dead and down is not limiting for elk, but it does influence the size of opening preferred.

JOB - IV

SPOTTED BEAR STUDY

The Research Committee has prepared a series of recommendations intended to assist the Spotted Bear Ranger District of the Flathead National Forest in improving elk winter range. The recommendations include suggestions for timing of the timber sale, road management, design of cutting units and evaluation of results.

ELK MANAGEMENT RECOMMENDATIONS FOR THE CONSIDERATION OF LAND MANAGERS

INTRODUCTION

The cooperative elk-logging study has concluded its 5th year and a large quantity of data have been gathered. Certain findings appear to be firmly based and worthy of consideration. In order that management can benefit from the study effort prior to the final report, the research committee has been directed by the steering committee to formulate tentative management recommendations or guidelines based on findings-to-date.

It is not intended that these recommendations be broadly applied throughout the forests of Montana. Likewise, it is not intended that they be considered the "last word" or an attempt to dictate management practices to public agencies or private corporations. It is intended that they be considered a portion of the wildlife input that should be evaluated, along with many other values and inputs, in the planning of all timber sales and road construction projects. If a recommendation fits the situation, in an identified elk-use area, its implementation will help minimize any detrimental impact on the elk in the area. The recommendations merely represent an attempt by the study team to place significant findings in the hands of management as the research study progresses.

The following recommendations, although based on the best information presently available, are considered tentative and subject to change; the hazards of extrapolation must be recognized. They may not apply to certain local situations and literal application should not be substituted for detailed, joint discussions and on-the-ground inspections by timber and wildlife managers and other resource specialists.

RECOMMENDATIONS

1. Research Finding:

During active road building and logging, elk have responded by moving to surrounding ridge lines and further. The distance moved apparently depends on a variety of factors including size of drainage, area encompassed by logging, intensity of logging activities, and disturbance on the ridge lines.

Elk displacement, which is considered temporary, has been detected as far away as 4 miles. In one instance, displacement was to an adjacent, undisturbed third order drainage. In another investigation, displacement was down a ridge-line for two miles through undisturbed timber and over a point. In both cases, topographic features provided a line-of-sight barrier between the elk and the logging activity.

Recommendation: Planning for timber sales in elk summer range should include provision of a security area immediately adjacent to the disturbed area during the active logging and/or road building period. This security area should provide a line-of-sight barrier and be inaccessible to motorized traffic. In some instances, this may be accomplished with an area closure.

The actual size of the security area should be determined by on-the-ground consultation between wildlife and timber managers. To realize the full value of this recommendation, the ridge-line between timber sale activities and the security area should remain intact with roads and logging activity below the skyline.

2. Research Finding:

When crossing roads, elk have indicated a preference for road sections through dense timber where visibility is relatively low and security relatively high.

Recommendation: During the location and design of transportation systems, existing elk movement patterns and probable elk crossing areas should be identified and provisions made to provide security for unimpeded movement. Where possible, several alternate routes should be considered. Primary consideration should be given to:

a) maintaining frequent dense cover areas adjacent to the road;

b) minimizing cuts, fills, and right-of-way clearings;

c) avoiding long stretches of straight road; and

d) providing adequate slash disposal along rights-of-way.

3. Research Finding:

Within the various study areas, findings-to-date indicate elk prefer those sites at the head of drainages bordering streams or marshy meadows, or occupying moist swales or benches. East of the Continental Divide, the dominant vegetative components of these sites are Subalpine fir, Whitebark pine, spruce, or combinations thereof. These sites are usually found within the *Abies lasiocarpa/Calamagrostis canadensis* and/or the *Abies lasiocarpa (pinus albicaulis)/Vaccinium scoparium* habitat types as described by Pfister, et al. (1974). In western Montana these moist sites are generally found within the *Abies lasiocarpa/Luzula glabrata* *(menziesia* phase), *Abies lasiocarpa/Clintonia uniflora, Abies lasiocarpa/ Menziesia ferruginea* and *Abies lasiocarpa/Galium triflorum* habitat types as described by Pfister, et al. (1974).

Recommendations; Moist sites (wet sedge meadows, bogs, seeps, etc.) have been identified as a very important component of elk summer range especially when these sites occur in the *Abies lasiocarpa/ Calamagrostis canadensis* and/or the *Abies lasiocarpa (pinus albicaulis)/ Vaccinium scoparium* habitat types in eastern and central Montana, and the *Abies lasiocarpa/Luzula glabrata (menziesia* phase), *Abies lasiocarpa/Clintonia uniflora, Abies lasiocarpa/Menziesia ferruginea* and *Abies lasiocarpa/Galium triflorum* types in western Montana.

Preferred summer elk range exists when these moist sites are interspersed with other necessary habitat components including various timber types and densities, dry broken and open parks, and various other physical characteristics.

Where these situations exist, an area large enough to maintain the overall integrity of the habitat components should be managed by protecting them from alteration. The size of the area to be managed should be determined by an on -the-ground inspection by land and wildlife managers and other appropriate resource specialists.

4. Research Finding:

Location and density of roads, and the use made of those roads, may be disturbing to elk, depending on intensity, type, and season of use, as well as other factors.

Recommendation: Wildlife managers should identify local area elk requirements to be used as a basic consideration in every road system plan or road management decision. Proposed road systems should be evaluated for impacts on elk on a case by case basis. Existing roads should be evaluated to see if abandonment or closures would enhance elk management. ORV closures should also be consiered, and Federal land managers should assess the suitability of the new Federal ORV regulation in this connection. State regulations may also apply to ORV use.

5. Research Findings:

Two phases of the project involved area closures which restricted motor vehicle travel to a few selected roads.

Results of the Judith Road Closure Study indicate little or no change in elk distribution or harvest resulting from imposed travel restrictions. Apparently, area closure measures were not necessary to "protect" elk under the existing pattern of cover and terrain. However, hunters reported seeing more elk under the restrictions than during unlimited seasons and seemed to prefer the limited access because of the "higher quality" hunt it afforded.

Results of the Ruby Road Closure Study indicate the area closure had a significant effect on elk distribution, harvest and hunter use of the area. This area was characterized by a relatively open, broken forest with gentle terrain and easy access. Elk stayed in the restricted area longer and in greater numbers than during pre-closure years, resulting in more uniform season-long hunting pressure and elk harvest. Although hunter participation decreased, hunter success increased and more elk were observed per hour of walking. Most hunters interviewed felt the quality of their hunt had been increased because of the area closure.

Recommendation: Before a vehicular closure is considered, the elk management goal or objective should be scrutinized and clearly defined, being especially cognizant of the following situations or potential problem areas:

It appears that closures will generally:

1. Change the relative quality of elk hunting in the closed area;
2. Reduce harassment of game animals; and
3. Present some problems because of increased difficulty for hunters retrieving bagged animals.

Road closures may be good or bad depending on the elk management goal or objective for a specific hunting unit or area. Depending on terrain, existing access and patterns of cover, effects of area closures on elk management could apparently vary:

1. From no change in hunter participation to a significant change;
2. From no change in elk distribution to a significant change, with elk staying in an area longer and in greater numbers; and
3. From no change in elk harvest to an increase or decrease, with a more uniform season-long harvest; hunters will usually see more elk per unit of walking effort.

6. Research Finding - Findings from investigations to determine seasonal elk distribution have increasingly indicated that the presence and distribution of domestic cattle has substantially influenced the distribution of elk on the Long Tom Creek summer range. Interspecific association measurements between elk and cattle showed a significant negative response of elk towards cattle. Displacement of elk appeared to be initially caused by social intolerance of cattle by elk. Displacement of elk was also suggested by research findings which indicated that elk preferred those areas on summer range where forage use averaged less than 25 percent.

Road construction and/or other associated timber harvest activities occasionally "open up" new areas for grazing or alter existing cattle grazing allotments on elk summer ranges, increasing the potential for elk-cattle conflicts in such areas.

Recommendation: An evaluation of elk and livestock management objectives and programs should be an integral part of the planning for any timber sale on important elk summer range. An evaluation of existing elk and livestock management objectives and programs is desirable for important elk summer ranges where livestock distributions on allotments have been influenced by timber harvest activities.

LITERATURE CITED

Pfister, Robert D., et al. 1974. Forest habitat types of Montana. U. S. Forest Service, Intermountain Forest and Range Experiment Station, Missoula, MT. 213pp.

JOB I

PROBLEM ANALYSIS AND COORDINATION PROGRESS REPORT FOR PERIOD JANUARY 1 - DECEMBER 31, 1974

INTRODUCTION

The objectives of this job are to identify the basic conflicts between timber harvest and elk ecology in the various forest types of Montana and to plan and coordinate research efforts. While these are basically unproductive activities from the viewpoint of findings, they are necessary for the smooth operation of the project and to insure that all objectives are fulfilled.

Committees

The project steering committee for 1974 included the following members:

Region I, USFS	Roger Bumstead, Chairman
Montana Dept. of Fish & Game	Wynn G. Freeman
Bureau of Land Management	Don McIntosh
Intermountain Forest and Range Experiment Station	Ralph Klawitter
School of Forestry, University of Montana	Robert Wambach

The project research committee for 1974 included the following members:

Montana Dept. of Fish & Game	Eugene O. Allen, Chairman Reuel G. Janson Terry N. Lonner
Intermountain Forest and Range Experiment Station	Joe Basile L. Jack Lyon
Bureau of Land Management	Richard Ellison Robert Bennett
Region I, USFS	Floyd Pond
School of Forestry, University of Montana	Robert Ream

ACTIVITIES

During the year 10 meetings were necessary for project planning and coordination. Twenty, 18, 21 and 28 coordination meetings were necessary in 1973, 1972, 1971 and 1970, respectively.

Date	Location	Meeting
Jan. 17, 1974	Kalispell	Met with Flathead Forest to discuss Spotted Bear Study.
Jan. 25	Wise River	Met with Beaverhead Forest to discuss Long Tom Cr. Study.
March 5-7	Bozeman	Steering Committee Meeting.
April 5	Missoula	Research Committee Meeting.
April 11 & 16	Helena	Met with U.P.I. reporter for feature news story.
May 30	Stevensville	Met with Stevensville Ranger District.
May 31	Bozeman	Project review for Les Batchelor, Forest and Range Expt. Station, Pangiora, New Zealand.
Aug. 6-7	Missoula	Steering Committee Meeting.
Sept. 30-Oct. 2	Ruby, Long Tom, Sapphires, Burdette Cr.	Study area tour for personnel of Salmon Nat. Forest and Idaho Fish and Game Dept.
Nov. 12	Bozeman	Project review for P-R coordinator from Denver.

During the year 19 talks or programs were presented to various groups. Nine, 5, 23 and 5 were presented in 1973, 1972, 1971 and 1970, respectively. Following is a listing of the year's programs:

Date	Organization	Speaker
Jan. 15-16, 1974	Mont. Dept. F&G Game Mgrs. Meeting, Missoula	Research Committee
Feb. 14	Philipsburg Sportsmens Club	Ream
Apr. 2	Butte Exchange Club	Lonner
Apr. 9	Interagency Meeting, Salmon, ID	Allen
Apr. 15	R-3 Fish & Game Dept. meeting, Bozeman	Allen

Date	Organization	Speaker
Apr. 15	Biology Class, Montana Tech., Butte	Lyon
Apr. 25	Skyline Sportsmens Club, Butte	Lonner
Apr. 30	Bozeman Rotary Club	Lonner
May 1	M.S.U. Wildlife Forum, Bozeman	Allen
May 15-16	Recommendations Workshop for land managers	Research Committee
May 30	Habitat typing school, Missoula	Lyon
June 6	Missoula C of C Natural Resources Council	Ream
Aug. 24	Mont. Wildl. Fed. Board of Directors, Gallatin Canyon	Allen
Sept. 22	SW Mont. Wildl. Fed., Dillon	Lonner
Sept. 25	Skyline Sportsmens Club, Butte	Lonner
Nov. 6	Gallatin Sportsmens Club, Bozeman	Lonner
Nov. 7	U ofM Wildl. Club, Missoula	Ream
Dec. 2	Butte Jr. High Science Class	Lonner
Dec. 4	Gallatin Sportsmens Club, Bozeman	Lonner

During the year, feature news stories or articles were provided to Station CKY, Winnipeg, and U.P.I., Helena. Other news stories were pursued with no results.

During the 1974 report period, research committee members were responsible for 9 publications:

1974 Publications

Cooperative Elk-Logging Study

Allen, E. O. and Terry N. Lonner. January 1974. Effects of logging on elk populations. Mont. F. & G. prog. rept. Proj. W-120-R-4, Jobs BG-3.04-3.12. 40pp.

Ream, R. R. January 1974. Wildlife, land use and people. Western Wildlands Jan. 1974. 5pp.

Research Committee February 1974. Cooperative elk-logging study plan. 25pp.

Zahn, H. M. May 1974. Elk habitat and forage relationships in a timber-browse range in Western Montana. M.S. thesis, Univ. of Montana, Missoula. 71pp.

Beall, R. C. June 1974. Winter habitat selection and use by a western Montana elk herd. Ph.D. thesis, Univ. of Montana, Missoula. 197pp.

Bohne, J. R. July 1974. Food habits, seasonal distribution, and habitat utilization of elk in the South Fork of Fish Creek, Lolo National Forest, Montana. M.S. thesis, Univ. of Montana, Missoula. 187pp.

Research Committee August 1974. Fourth annual cooperative elk-logging study progress report, January 1-December 31, 1973. 164pp.

Allen, E. O. and Terry N. Lonner August 1974. Effects of logging on elk populations. Mont. F. & G. Dept., prog. rep., Proj. W-120-R-5, Jobs BG-3.04-3.12. 70pp.

Research Committee December 1974. Nine presentations in "Proceedings 1973 Western States Elk Workshop" held in Bozeman, Montana, Feb. 20-21, 1973. Eugene O. Allen and Howard R. Chrest, co-chairmen. 151 pp.

The annual summer field tour was rained out the first day and the Sapphire study area was viewed the second day - 15 persons were in attendance. Some time was also spent discussing details of a Wild Kingdom TV program that will be filmed during 1975.

A major accomplishment during the report period was the finalization of 5 management recommendations based on research findings from the study. A land managers workshop was held in Missoula to assist with final revision of these recommendations.

Another significant accomplishment was the completion of a bibliography on elk and logging adapted for use with a computerized documentation system called Famulus. Each of 276 citations was condensed into 10 fields: author, title, publication description, accession number, taxon, geographic description, outline topic, abstract, parameters and keywords. The keyword field presently has 192 entries. This bibliography is on magnetic tape and is available for distribution by writing to: Terry Lonner, Montana Department of Fish and Game, Research Section, Box 5, MSU, Bozeman, MT. 59715. The bibliography will be updated annually.

Considerable other time was spent preparing study plans and budgets, preparing news releases, reviewing literature, reviewing pertinent studies in other states, updating the report mailing list and answering correspondence received asking about various aspects of the elk-logging study.

Submitted by: Eugene O. Allen

JOB II-A
Procedure B-1

CONDUCT ANNUAL PELLET COUNT SURVEYS TO DESCRIBE ELK DISTRIBUTION PATTERNS WITHIN THE BURDETTE CREEK-DEER CREEK AREA

Progress Report for the Period January 1 - December 31, 1974

INTRODUCTION

Pellet distribution surveys in Burdette Creek, Deer Creek and adjacent drainages were initiated in the fall of 1970. The major objectives of these surveys were (1) to describe elk distribution patterns before, during, and after the timber sale in Deer Creek, and (2) to describe elk use of the available environment.

As in previous reports of this series, objective 1 has been given first priority and objective 2 has only been partially examined.

METHODS

A complete description of the methods used to collect pellet-count data was presented in the 1973 progress report. In brief, the technique involves recording pellet groups in belt transects located on 500-foot contours throughout the study area. Transects are divided to provide information for each 40-acre block and each segment representing an aspect change within a 40.

During 1974, a total of 388.3 miles of pellet-group transect was surveyed during the period August 26 to September 6. This compares to 277.2, 320.5, 324.7, and 383.9 miles in the years 1970 through 1973.

ANALYSES

For the first time since 1970, more than 10,000 elk pellet groups were recorded and the downward trend in total elk population was apparently arrested. Table 1 suggests a possible population increase of about 10 percent.

Table 1. - Numbers of elk pellet groups counted by Years and Relative Estimated Population Size, Burdette Creek-Deer Creek Study Area, 1970 to 1974

Year	Total Pellet Groups Counted	Total Miles of Transect	Pellet Groups per Mile
1970	10.830	277.2	39.1
1971	9.651	320.5	30.1
1972	7.856	324.7	24.2
1973	9.048	383.9	23.6
1974	10.126	388.3	26.1

However, the numbers of pellet groups in the very old category is still increasing in these data (table 2), suggesting that the actual increase in population may be somewhat smaller than 10 percent.

Table 2. - Pellet groups per mile by Age Class, 1970 to 1974

	Year				
Age Class	1970	1971	1972	1973	1974
Fresh	1	1	0	0	0
New	9	5	3	3	2
Old	19	14	10	9	11
Very old	10	11	11	12	13
Total	39	30	24	24	26

Elk Distribution

As each additional year of data has been added to the Burdette Creek-Deer Creek record, it has become more apparent that the single most important variable controlling distribution of elk pellet groups is winter weather. With the exception of Deer Creek, and possibly the Hyde-Lupine subunit, each of the nine subunits listed in table 3 has some acreage normally used as winter range by elk. The largest area, and the core of the winter range, is located in Burdette Creek and Lupine Creek. However, Eds, Gus, and Johns Creeks and the south fork of Petty Creek all have southerly aspect openings at or below 5,500 feet while the western third of the study area from Wall Canyon south to Wig Creek and Owl Creek, has substantial areas of open grassland and shrubfield on southwest aspects. Thus, the changes in elk distribution indicated in Fig. 1 require interpretations involving both the logging activity in Deer Creek and the responses of elk to winter conditions preceding the count period. Recognition of weather responses is particularly important for the eastern third of the study area because transects in Eds, Gus, and Johns Creek and the south fork of Petty Creek are all above 5,000 feet. In severe winters, elk are forced to remain below this altitude and thus, contribute little to the pellet sample. Conversely, in mild winters, the numbers of elk above 5,000 feet contribute to the sample out of proportion to any real changes in distribution or populations. On the remainder of the study area, transects sample down to 3,500 feet, but the differential response to winter weather is nevertheless apparent.

Table 3. - Elk distribution trends, pellet groups per mile as a percentage of the mean for the total study area 1970 to 1974

Subunit	Year 1970	1971	1972	1973	1974
Wall Canyon to Lion Creek	78	95	105	68	107
Deer Creek above Wall Jct.	68	56	45	34	26
Eds Creek and Gus Creek	100	80	78	112	72
Wig, Owl and upper Hyde	90	108	82	66	74
Burdette Creek above 5,000 feet	70	92	61	101	84
Burdette Creek below 5,000 feet	168	173	210	195	215
Johns Creek and S. Fork Petty	95	76	87	100	87
Lower Hyde, Burdette, Lupine	79	73	80	55	59
Upper Lupine Creek	114	125	141	147	167
Pellet Groups Per Mile	39	30	24	24	26

Because winter weather effects are so apparent in the available data, some specific studies of snow depths and elk responses to weather conditions are planned for future reports on the Burdette Creek-Deer Creek study. However, in this report, winter weather is presented only as a subjective evaluation in comparison with the "average" for western Montana. In this context, the sequence of events for the past 5 years and the responses of elk to those events are summarized as follows:

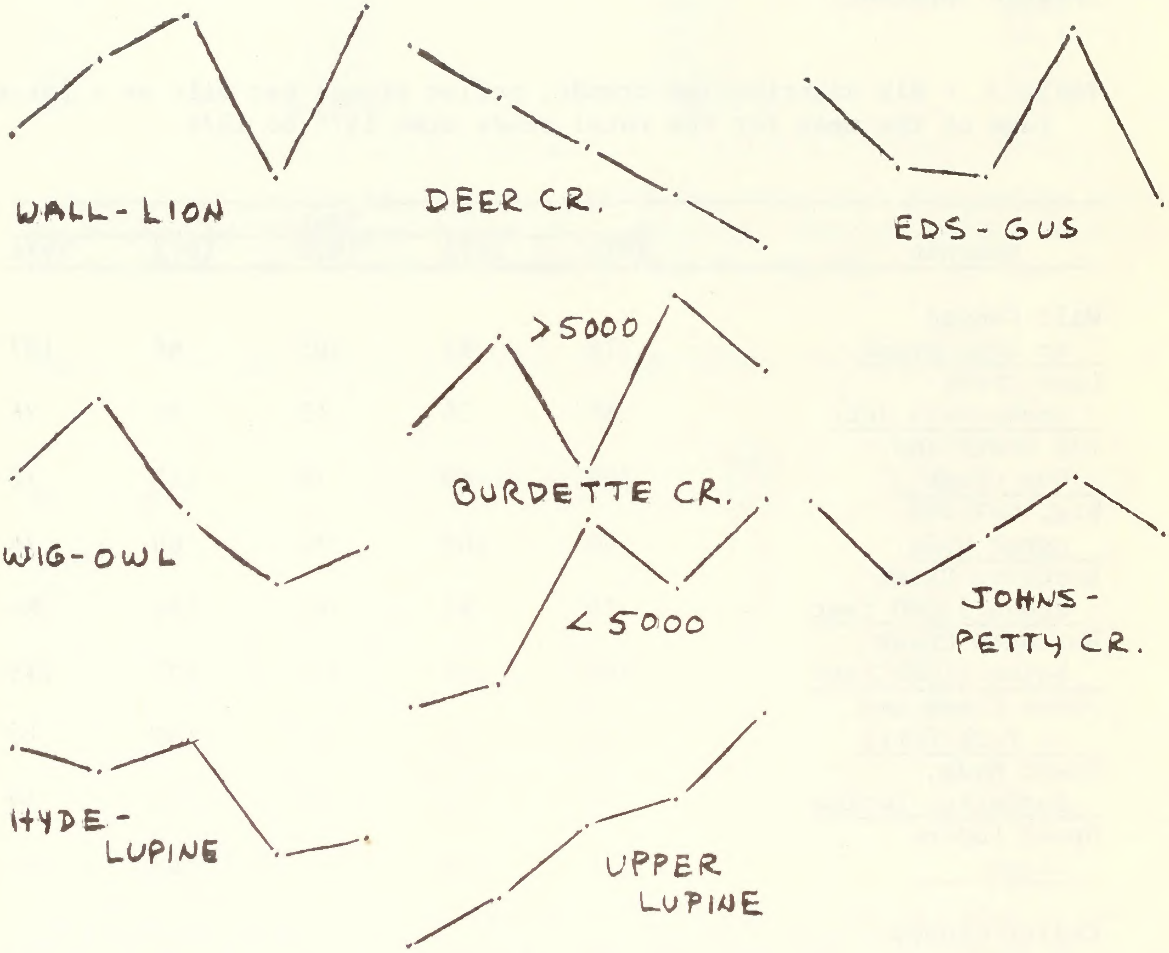


FIGURE 1.- FIVE YEAR TREND OF ELK-PELLET DENSITIES IN NINE SUBUNITS OF BURDETTE CREEK - DEER CREEK STUDY AREA, 1970 - 1974.

1969 to 1970 (1970 count)

Human activity in the study area involved only the hunting season in 1969 plus the normal summer traffic of fire patrols and recreation vehicles. Road construction into Deer Creek was initiated in August 1970, but it has been assumed that most of the elk pellets counted were deposited before this activity started. The winter of 1969-70 was relatively mild for western Montana. Thus, the 1970 pellet counts were considered representative of undisturbed elk distribution following a not very severe winter.

1970 to 1971 (1971 count)

Beginning in September 1970, activity in Deer Creek increased from occasional foot travel to substantial road construction, daily logging traffic and major modifications of forest cover. Most of the logging activity during this period was confined to the northeast quarter of the drainage. The winter of 1970-71 was considered average or normal for western Montana.

Elk response to the timber sale and road construction activity in Deer Creek was manifest in an immediate decline in numbers of pellet groups and a concurrent increase in pellet groups in all adjacent drainages except Eds Creek. The initial changes in elk pellet distribution suggest that movement across the nearest undisturbed topographic barrier was adequate to satisfy requirements for security. Wall-Lion, Wig-Owl and Burdette above 5,000 feet are all within about 2 1/2 miles of the cutting area, but in each case a major topographic barrier separates the logging activity and the elk-use area. Eds Creek, on the other hand, is just over a ridgeline divide from the activity in Deer Creek and the divide was accessible by way of a new road out of the logging area. This road was never used by logging traffic, but it did cut through an elk movement corridor identified in the 1970 pellet counts and can probably be considered responsible for the failure of elk to move into Eds Creek.

Winter weather effects on elk distribution are indicated in most of the remaining subunits. Eds-Gus and Johns-Petty declined because the winter use was below 5,000 feet, and Burdette below 5,000 and upper Lupine both increased because the core winter range was more heavily used.

1971 to 1972 (1972 count)

During this period, logging and road construction activity continued in Deer Creek but it was no longer confined to the northeast quarter. Road construction, in particular, was very active on the slopes adjacent to the ridgeline between Deer and Burdette Creeks and one spur road was constructed to a saddle in this divide. Also noted during this period was another active timber sale in the Howard Creek drainage outside the study area but immediately south of the Johns-Petty subunit. The winter of 1971-72 was, again, about average for western Montana.

The more widespread activity in Deer Creek corresponds to a further decline in pellets within the drainage and concurrent increases elsewhere. However, Wall-Lion was the only adjacent subunit with an increase. Wig-Owl and Burdette above 5,00 feet were less than a mile from the new activity and partially visible from the spur road in the saddle. As a result, use of these areas declined substantially and elk moved another 2 to 4 miles to Burdette Creek below 5,000 feet and upper Lupine Creek. It is also probable that the increase in upper Lupine Creek was enhanced by elk moving away from the Howard Creek sale area. This movement was also detected in the Johns-Petty Creek subunit. Winter weather since it was very similar to the preceding year, caused no major change in elk distribution.

1972 to 1973 (1973 count)

Activity in the study area during this period included continuation of the timber sale in Deer Creek and further cutting in Howard Creek just south of the Johns-Petty subunit. In addition, there was some active logging on private land near the mouth of Lupine Creek and initial sales preparation and marking was conducted in the Garden Point area between Johns Creek and the south fork of Petty Creek. Finally, several attempts were made to dart elk and a corral trap was installed in Wig Creek. The winter of 1972-73 was exceptionally mild and was followed by a hot, dry summer. In August, just prior to the pellet count survey, most of the National Forest land in western Montana was closed because of the high fire danger.

Elk use of Deer Creek continued to decline, but most of the recorded changes in elk distribution appear to be associated with weather rather than human activities. Pellet distributions suggest that most elk were able to winter above 5,000 feet. Thus, Eds-Gus, Johns-Petty, Burdette above 5,000, and upper Lupine all demonstrated increased use while the entire west half of the study area, from Wall Canyon to Lower Hyde Creek, and Burdette below 5,000 had decreased use. The declines on the west side were further enhanced by dry summer conditions, the elk trapping activity and selective logging while increases upper Lupine and Johns-Petty were probably enhanced by the Howard Creek Sale.

1973 to 1974 (1974 count)

Timber sale activity in Deer Creek remained at an extremely low level during this period because the contractor had removed most of his equipment during the 1973 fire danger closure. However, the logging activity in Hyde-Lupine continued and the corral trap in Wig Creek was activated from March through July. There was also some minor activity on the Garden Creek sale (Johns-Petty subunit), but the most important factor contributing to elk distribution changes was winter weather. The winter of 1973-74 was much more severe than the previous winter and about average for western Montana.

In general, the elk distribution changes in Fig. 1 appear to be responses to weather rather than human activities. Deer Creek continued to decline, Wig-Owl remained low because of the trapping activity and Hyde-Lupine was influenced by logging. Otherwise, elk use of areas above 5,000 feet declined and use of areas below 5,000 feet increased.

1974 to 1975

Hauling of decked logs in Deer Creek was completed during September of 1974 and the road system was blocked about mid-October before the general hunting season. There will probably be some slash burning and general cleanup work during the summer of 1975, but for all practical purposes the Deer Creek sale is completed and the 1975 pellet counts will represent the first postsale inventory of elk distribution. The Garden Creek sale will probably be active during this period, and the winter of 1974-75 will probably prove to be the most severe in recent years.

SUMMARY

During the 5 years of study, elk distributions in the Burdette Creek-Deer Creek study area have demonstrated a continuous negative response to an active timber sale in Deer Creek and similar responses to other logging activity on the periphery of the study area. In general, this effect appears to extend to the nearest major topographic barrier which will separate elk from the activity area. Protection of ridgelines between active logging and the area selected by elk as adjacent security appears to be particularly important.

Weather, particularly winter weather, is also an extremely important determinant of elk distributions. Throughout the study area, pellet distributions suggest that elk spend the winter at the highest altitude allowed by snow depths. During the 5 years of study, winter range concentrations of pellets have shifted from 4,500 feet in normal winters to 5,500 feet in an extremely mild winter.

Submitted by: L. Jack Lyon

Job II-A
Procedures B-2, B-3.a and B-3.b
ELK HARVEST, DISTRIBUTION AND FOOD HABITS
Progress Report for the Period
Jan. 1, 1974 - Dec. 31, 1974

INTRODUCTION

The collection of hunting and harvest data at three checking stations was continued in 1974 for the fifth consecutive year. Very mild weather prevailed throughout the hunting season and this was the major reason for poor hunting success and a relatively low elk harvest.

Tom Lemke continued the elk movement study begun by Max Zahn. Movements were determined chiefly by monitoring elk instrumented with radio transmitters. As many as thirteen transmitters were in operation at one time.

Additional information on elk habitat type use became available with the completion of Joseph Bohnes thesis.

METHODS

Three checking stations were operated at the same locations as in 1970-1973. The Lolo and Fish Creek stations were operated the first three days of the early branch-antlered elk season, and the Petty Creek station was operated for the first two days. During the general season, the Lolo and Fish Creek stations were operated each day of the 12-day either-sex season, and weekends thereafter until the close of the antlered elk season. The Petty Creek station was run only on weekends.

The number of hunters and the sex, age and locations of elk and deer kills were recorded. Jaws or middle incisors were collected whenever possible to provide more accurate age data. Jaws and incisors were submitted to the Bozeman lab for aging. These determinations are not yet available.

Occasional flights and ground surveys were made to document distribution, numbers and sex-age composition of the elk herd.

Elk were trapped in the Wig Creek trap, ear-tagged, neck-banded and fitted with radio transmitters in connection with the graduate student elk movement study. Periodic flights and ground surveys were made to monitor movements of the radioed elk.

FINDINGS AND DISCUSSION

Hunting Pressure

The 1974 general hunting season in Hunting District 230, which includes the study area, was October 20-31 for either-sex elk, and November 1-17 for antlered elk. There was also a five-day early branch-antlered bull season

September 15-19. The general season regulations were similar to the 1973 season. However, there was no early bull season in 1973.

Hunting pressure by various periods for the total area covered by the checking stations is shown in Table 1. The total number of hunters checked in 1974 was 4892. This represents a small increase over the 1973 number, which was unusually high compared to previous years. The 1974 increase was due to the 606 hunters checked during the early bull season. The distribution of hunting pressure by time periods during the general season was similar to previous years except that hunter participation on the opening day of the early bull season was much higher than in 1971 and 1972, which were prior years with early bull seasons. This was due to the opening day, September 15, falling on a Sunday in 1974.

A total of 94 elk was checked during the 1974 season. Seventeen percent was taken during the early bull season, 82 percent during the 12-day either-sex season, and only one percent during the later general antlered bull season.

Table 1. Checking station data by time periods from the Lolo, Fish Creek, and Petty Creek stations, 1970 - 1974

	No. Hunters					Elk Checked				
Period	1970	1971	1972	1973	1974	1970	1971	1972	1973	1974
Early Bull Season										
1st day	--	204	120	--	451	--	7	15	--	7
2nd day	--	208	141	--	114	--	13	7	--	5
3rd day	--	33	123	--	41	--	8	0	--	4
Regular Season										
1st Sunday	433	405	273	608	710	22	9	23	10	13
1st week *	285	--	391	898	657	50	0	7	58	40
2nd weekend	509	401	516	935	883	13	5	15	23	20
2nd week *	86	--	64	47 1/	203	5	--	1**	3 1/	4 2/
3rd weekend	370	419	341	728	598	6	15	4	16	0
3rd week *	73	--	--	--	--	12	--	--	--	0
4th weekend	339	651	340	702	686	2	7	3	11	1
4th week *	61	--	--	--	--	1	--	--	--	--
5th weekend	209	272	37	623	549	1	1	0	5	0
6th weekend	291	302	--	--	--	6	3	--	--	--
7th weekend	183	242	--	--	--	2	2	--	--	--
Totals	2839	3137	2346	4541	4892	120	70	75	126	94

* week days only

** the either-sex season ended on Tuesday, Oct. 31

1/ the either-sex season ended Wednesday, Oct. 31. Checking during the week was done only Monday at the Lolo Creek station

2/ Either-sex season ended Thursday, October 31

Elk Harvest

The area covered by the checking stations was divided into eight units, consisting of the study area and surrounding segments (Fig. 1). Elk harvests from these units, from portions of the study area, as well as total harvests, are shown in Table 2. Total checked kills were 116 in 1963, 127 in 1970, 89 in 1971, 77 in 1972, 128 in 1973 and 94 in 1974. Fluctuation in harvest numbers was chiefly due to variations in the length of the either-sex season and weather conditions. Early bull seasons in some years and changes in the resident (summer) elk population of the study area were also contributing causes. The winter elk populations of the study area has apparently not declined, and may have increased since 1970.

Table 2. Geographic distribution of the elk harvest checked at the Lolo, Fish Creek and Petty Creek stations

	1963		1970		1971		1972		1973		1974	
	Elk checked		Elk Checked		Elk checked		Elk checked		Elk checked		Elk checked	
Area of Kill	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
S.Lolo Creek	7	6	6	5	9	10	6	8	15	12	9	10
N.Lolo Creek	29	25	13	10	13	15	16	21	14	11	15	16
W. Fish Creek	5	4	8	6	13	15	5	6	7	5	4	4
N.FK Fish Creek	28	24	52	41	20	22	35	45	54	42	41	44
Rock Cr.-Meadow	3	2	4	3	2	2	0	0	3	2	0	-
Study Area												
Wagon Mtn. Rd.	1	1	3	2	0		1	1	1	.8	0	
S.Fk. Fish Cr.	1	1	1	1	0		0		0		0	
Sullivan Cr.	0		0	1	0		0		1	.8	0	
Lupine Cr.	0	0	5	4	6	7	1	1	0	-	1	1
Burdette Cr.	6	5	5	4	2	2	1	1	2	1.6	0	-
Hyde Cr.	0		0		2	2	0		0		0	-
Owl Cr.	0		3	2	1	1	0		1	.8	0	-
Wig Cr.	0		3	2	0		1	1	2	1.6	0	-
Lion Cr.	0		1	1	0		0		0		0	-
Deer Cr.	7	6	4	3	2	2	0	0	2	1.6	1	1
Wall Canyon Cr.	0		0		0		0		0		1	1
W.Fk.Petty Cr.	0		0		3	4	1	1	2	1.6	2	2
Eds Creek	0		1	1	1	1	0		1	.8	1	1
Gus Creek	0		0		1	1	0		0		0	-
Johns Creek	1	1	0		0		0		0		0	-
S.Fk.Petty Cr.	0	0	7	6	1	1	0	0	2	1.6	1	1
Sub-Total	16	14	33	26	19	21	5	5	14	11	7	7
N.Fish-W Petty	0	0	2	2	2	2	2	3	2	2	2	2
E. Side Petty *	3	3	6	5	8	9	8	10	14	11	13	14
Misc.Lolo Cr.	2	2	1	1	3	3	0	0	0	-	0	-
Misc.Fish Cr.	9	8	0	0	0	0	0	0	4	3	2	2
Misc.Petty Cr.	14	12	2	2	0	0	0	0	1	1	1	1
Grand Total	116	100	127	100	89	100	77	100	128	100	94	100

* Includes Tank Cr.-Corral Cr. area

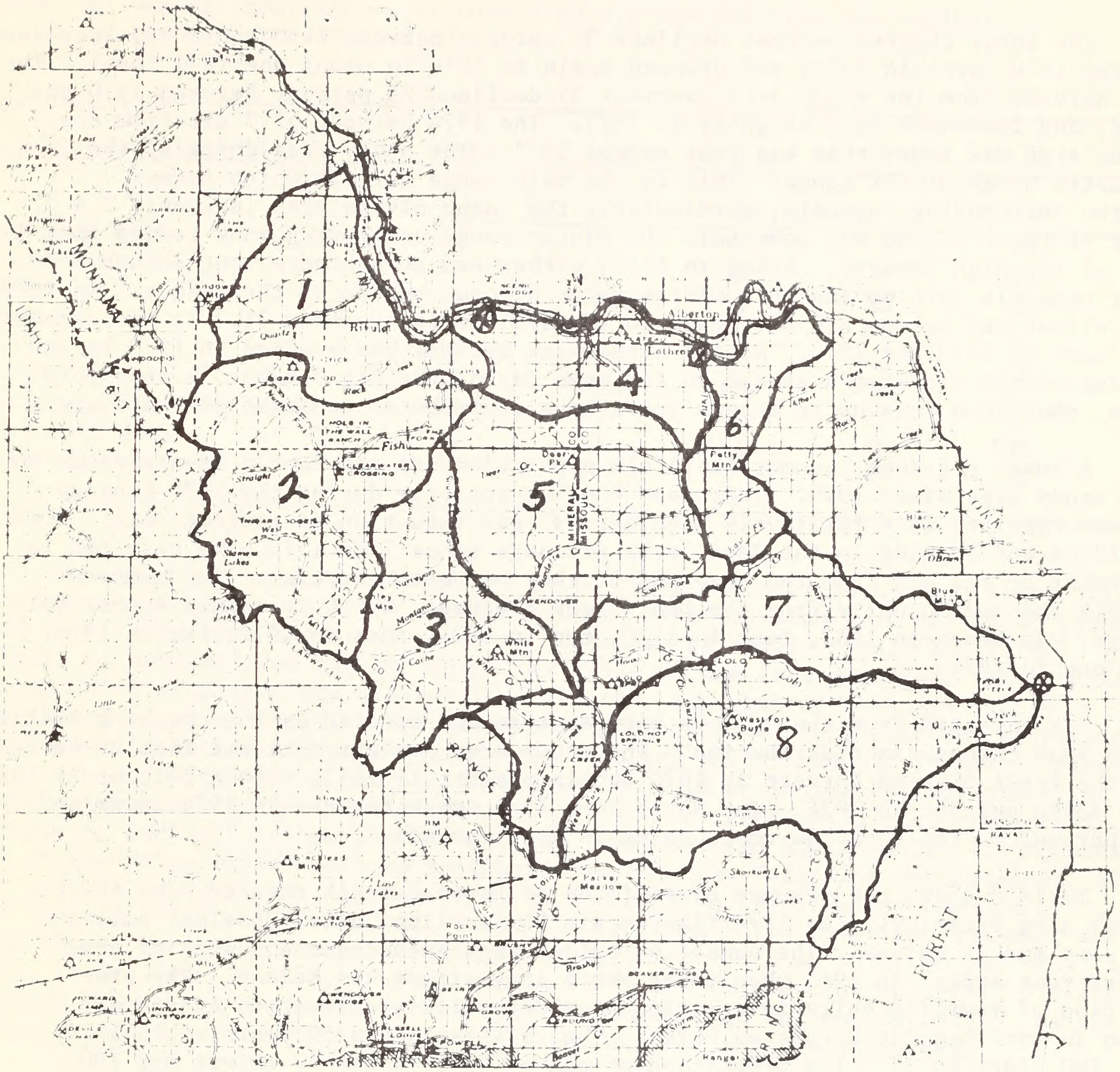

1
2
3
4
5
6
7
8
MONTANA
IDAHO
CLARK FORK
Rivulet
Alberton
Lothrop
Fish
Petty Mtn
Blue Mtn
MINERAL
MISSOULA
Lolo
West Fork Butte
Packer Meadow
Powell
FOREST
RANGE

Figure 1. Elk harvest segments in area checked by Lolo Creek, Fish Creek and Petty Creek checking stations

X - Checking station location
1 - Quartz Creek-Meadow Creek
2 - North Fork Fish Creek
3 - West Fish Creek
4 - North Fish Creek
5 - Study Area
6 - East Petty Creek
7 - North Lolo Creek
8 - South Lolo Creek

The total checked harvest declined 34 percent between 1970 and 1972, increased to the 1970 level in 1973, and dropped again in 1974 to about the 1971 level. The elk harvest from the study area (segment 5) declined 85 percent between 1970 and 1972, and increased only slightly in 1973. The 1974 harvest of 7 elk from the study area was lower than any year except 1972. The study area contains the Burdette Creek winter range. This is the main range for elk which summer in the surrounding segments, particularly the Idaho divide area (segments 2 & 3). Most of these elk do not come onto the winter range until deep snow forces them out of the high country. Prior to 1972, either-sex seasons were long enough so that some elk were moving onto winter range before the end of the season. In 1972 the either-sex season was shortened to 10 days, ending October 31. It was essentially the same in 1973 and 1974. A high either-sex harvest was averted in 1973 by the ending of the either-sex season on the same day of the big October 31 snowstorm. Thus, shortened seasons in recent years have contributed to lower elk harvests.

A lower resident (summer-fall) elk population has apparently been present in the study area since 1970. Increased hunting activity during the 1970 hunting season resulted in a relatively high harvest and reduction of resident elk. Road-building and logging in the Deer Creek drainage since late 1970 have resulted in movement of the elk from the area and further harvest reduction. The numbers of elk checked annually from the Deer Creek drainage, which is mainly summer-fall range, was seven in 1963, four in 1970, two in 1971, none in 1972, two in 1973, and one in 1974.

Elk harvests from the various harvest segments covered by the checking stations also show changes in distribution. The study area harvest declined from 26 percent of the total checked harvest in 1970 to six percent in 1972, eleven percent in 1973, and seven percent in 1974. The North Fork Fish Creek harvest in 1974 comprised 44 percent of the total harvest, which is about normal.

Table 3 shows the sex-age composition of harvested elk checked from the study area vicinity. The 1974 figures are 14 yearling bulls, 36 older bulls, 30 cows and 14 calves. The number of bulls taken exceeded the number of cows every year except in 1963 when there was a long either-sex season. The proportion of yearling bulls in relation to older bulls was lower in every year than in more heavily-harvested herds. The 1974 ratio was 39 yearling bulls per 100 older bulls. The proportion of calves in 1974 was 47 calves per 100 cows, which represents a relatively high proportion of calves for the area compared with previous years.

Table 3. Sex-age composition of harvested elk checked from the vicinity of the Burdette Creek Study Area

Sex-age Class and Ratios	1963	1970	1971	1972	1973	1974
	No. of elk					
Yearling Bulls	10	18	14	6	16	14
Older Bulls	34	43	50	39	49	36
Total Bulls	44	61	64	45	65	50
Cows	58	54	34	23	47	30
Calves	19	11	10	8	16	14
Total Elk	121	126	108	76	128	94
Yearling/100 Older Bulls	29	42	28	15	33	39
Bulls/100 Cows	76	113	188	196	138	167
Calves/100 Cows	33	20	29	35	34	47

Harvested elk were age-classified to the year whenever possible. These data are shown in Table 4. All elk checked at the three stations were included, rather than just those from the study area, to increase the sample size. The large numbers of unclassified adults reduce the value of the data somewhat, since these detract more from some age classes than others. Age classes that are easily identified by game checkers, and are probably represented in their true proportions in the total checked harvest, are calves, yearling bulls, and old animals. Also, since the majority of the unclassified animals would be in the "prime" class, a somewhat exaggerated estimate of the numbers and percentages in the prime class can be made by adding together the "prime" and "unclassified adult" columns. Accordingly, elk in the prime class would be somewhat less than the following percentages: 65 per cent in 1963, 58 per cent in 1970, 66 per cent in 1971, 71 per cent in 1972, 61 per cent in 1973, and 60 per cent in 1974. Yearling bulls comprised somewhat more than 19 per cent of the male harvest in 1963, 30 per cent in 1970, 20 per cent in 1971, 12 per cent in 1972, 20 per cent in 1973, and 25 per cent in 1974. Old-aged elk (smooth 1st molar) comprised one percent of the checked harvest in 1974. Calves comprised 12 per cent of the male and 19 per cent of the female harvest.

Table 4. Age composition by year class of elk killed in the vicinity of the Burdette Creek study area.

		½ Year		1½ Year		2½ Year		Prime		Old		Uncl. Adult		Total	
Year	Sex	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1963	Male	9	17	10	19	6	11	6	11	0	0	22	42	53	100
	Female	10	15	3	4	3	4	3	4	1	2	48	71	68	100
	Both	19	16	13	11	9	7	9	7	1	1	70	58	121	100
1970	Male	5	8	18	30	7	11	25	41	4	7	7	11	66	100
	Female	6	11	3	6	8	15	17	31	1	2	25	46	60	100
	Both	11	9	21	17	15	12	42	33	5	4	32	25	126	100
1971	Male	5	7	14	20	6	9	22	31	0	0	22	32	69	100
	Female	5	13	1	3	4	10	15	38	1	3	13	33	39	100
	Both	10	9	15	21	10	9	37	34	1	1	25	32	108	100
1972	Male	4	8	6	12	3	6	20	41	0	0	16	33	49	100
	Female	4	15	2	7	2	7	3	11	1	4	15	56	27	100
	Both	8	11	8	11	5	7	23	30	1	1	31	41	76	100
1973	Male	7	10	14	20	7	10	33	48	1	1	7	10	69	100
	Female	9	16	5	9	2	4	11	19	4	7	26	45	57	100
	Both	16	13	19	15	9	7	44	35	5	4	33	26	126	100
1974	Male	7	12	14	25	8	14	8	14	1	2	19	33	57	100
	Female	7	19	0	--	0	--	5	14	0	-	25	68	37	100
	Both	14	15	14	15	8	9	13	14	1	1	44	47	94	100

Population Trend and Composition

Winter elk populations in the study area have not varied much. Aerial counts were 151 in April, 1971; 133 in December, 1971; 141 in April, 1973, and 150 in December, 1973. No aerial count was made in 1974; however, a count of 201 was made May 1, 1975.

Winter herd composition data were obtained by ground counts in Burdette Creek on March 18, 1974. A sample of 91 different elk indicated a herd composition of 25 bulls and 38 calves per 100 cows. These ratios are similar to those of previous years (Table 5). Tom Lemke's data for the period November, 1974 to April, 1975 show ratios of 40 bulls and 53 calves per 100 cows in a total sample of 890 elk.

Table 5. Classified counts of elk in Burdette Creek area

Period	Bulls Spike	Bulls B.A.	Bulls Total	Cows	Calves	Total Elk	Sp./100 B.A.	Bull/ 100 Cows	Calves 100 Cows
Fall-Winter,1970-71	18	42	60	340	101	501	43	18	30
Fall-Winter,1971-72	40	49	89	309	128	526	82	29	41
July-September,1972	3	9	12	60	25	97	33	20	40
March-April,1973	2	6	8	37	14	59*	33	22	38
June-November,1973	6	19	25	94	40	159	31	24	42
March,1974	6	8	14	56	21	91*	75	25	38
Nov.1974-April,1975	60	129	189	459	242	890	47	41	53

*Unduplicated samples

Movements

Fourteen elk were trapped and marked at the Wig Creek trap during the period April - July, 1974, bringing the total of marked elk to 22 (Lemke, 1975). Ten radio collars were functional during most of the year. Marking data and current status of each marked elk are shown in Table 6.

Lemke obtained information on movements from 383 observations (visual and radio) of marked elk. These data indicated that movements were similar to those found by Zahn (1974). A small part of the winter herd remained in the vicinity of the winter range year-long, while the majority moved to summer range west of Fish Creek. Movements to summer range occurred during the first half of June and ranged between 6 and 11 miles. Elk returned to the winter range during a three or four week period in late November and December in response to snow depths. Two elk used the same summer areas each year, while three used different summer ranges. All radioed elk returned to the same drainages on the winter range each year.

Use of Habitat Types

Bohne (1974) determined elk use of cover types by classifying the vegetation at the site of each elk observation according to criteria used by Lyon (1973). His findings, concerning the winter range area, are similar to those of Zahn (1974). However, Zahn, by means of aerial radio tracking, found considerable summer and fall use of subalpine fir types while Bohne did not. A summary of Bohne's findings follows:

Elk were found chiefly on southeast- to west-facing aspects at 4,300 to 5,000 feet during winter. During spring and summer, they shifted to higher elevations and dispersed over all aspects. Use of northerly aspects was greatest during the rut and hunting season.

Open cover types were used during winter and spring. As summer progressed, elk used timber during the day and clearings at night. Use of timbered cover types was greatest during rutting and hunting seasons.

Table 6. Record of marked elk

Elk	Sex-Age[1]	Date & Location Marked	Collar Type & Color	Eartag No. Left	Eartag No. Right	Status
A'	♀ adult	4-27-72 Burdette Cr.	Radio (PA)[2] Wide Yellow	R0555	R0554	Radio dead as of 6-72 Last sited 5-1-75
B'	♀ adult	3-24-72 Burdette Cr.	Radio (PA)[2] Blue	R0551	R0552	Radio dead as of 8-72 Last sited 4-18-75
C'	♀ adult	4-20-72	Radio (PA)[2] White	none	R0553	Radio dead as of 8-72 Last sited 5-1-75
D'	♂ 2½ yr.	5-31-72 Wig Creek	Radio (PA)[2]	6803-A	6804-A	Radio dead as of 8-72 Shot 10-31-72
A	♀ adult	4-5-74 Burdette Cr.	Radio (PVC pipe) w/green tape	none	none	Last radio approximation 5-13-75
B	♀ adult	4-5-74 Burdette Cr.	Radio (PVC pipe) w/black tape	6929-A	6930-A	Last sited 4-24-75
C	♂ 4 yr.	4-5-74 Burdette Cr.	Radio (PVC pipe) w/ red tape	none	none	Last radio approximation 5-13-75
D	♀ adult	5-26-74 Wig Creek	Radio (PVC pipe) w/blue tape	6821-A	6822-A	Last sited 5-1-75
B-1	♀ adult	6-17-74 Wig Creek	Belt Red, white, & blue	6945-A	6946-A	Last sited 5-1-75
B-2	♂ 2 yr.	7-12-74 Wig Creek	Belt Black & white	6910-A	6911-A	Last sited 5-1-75
R-1	♀ adult	7-12-74 Wig Creek	Rope #442 Red-red I.D. flags[3]	6901-A	6902-A	Last sited 7-12-74
R-2	♀ adult	7-12-74 Wig Creek	Rope #444 Green-green I.D. flags[3]	6903-A	6904-A	Last sited 4-10-75
R-3	♀ 1 yr.	7-12-74 Wig Creek	Rope #448 Orange-orange I.D. flags[3]	6908-A	6909-A	Last sited 4-26-75
R-4	♀ 1 yr.	7-12-74 Wig Creek	Rope #450 Blue-blue I.D. flags[3]	6907-A	6906-A	Last sited 4-24-75

Table 6. Record of marked elk (cont.)

Elk	Sex-Age[1]	Date & Location Marked	Collar Type & Color	Eartag No. Left	Eartag No. Right	Status
R-5	♀ adult	7-12-74 Wig Creek	Rope #452 Green-red I.D. flags[3]	6912-A	6913-A	Shot during fall 1975
R-6	♀ adult	7-14-74 Wig Creek	Rope #454 White-red I.D. flags[3]	6914-A	6915-A	Last sited 4-26-75
1	♀ 5-6 yr.	4-11-73 Wig Creek	Radio (PVC pipe) Belt green & white	6811-A	6814-A	Radio dead as of 8-75 Last sited 4-26-75
2	♂ 1½ yr.	5-1-73 Wig Creek	Radio (SA) Belt Green[4] & white	6926-A	6813-A	Shot 10-6-73
3	♀ 10^+ yr.	5-1-73 Wig Creek	Radio (PVC pipe) Belt black, white, & green	6927-A	6928-A	Radio dead as of 4-75 Last sited 4-24-75
4	♀ 4 yr.	5-1-73 Wig Creek	Radio (PVC pipe)[5] w/black tape	6929-A	6930-A	Last sited 4-24-75
5	♀ 5-6 yr.	5-1-73 Wig Creek	Radio (PVC pipe) Belt Blue & white	6931-A	6932-A	Radio dead as of 11-73 Last sited 4-26-75
6	♀ 6-7 yr.	5-2-73 Wig Creek	Radio (PVC pipe) Belt black & white	6934-A	6935-A	Radio dead as of 7-74 Last sited 3-22-75
7	♀ 5-6 yr.	5-13-73 Wig Creek	Radio (PVC pipe) w/black stripe	6817-A	6819-A	Radio dead as of 4-75 Last sited 4-10-75
8	♀ adult	5-18-74 Wig Creek	Radio (PVC pipe) w/yellow tape	6942-A	6941-A	Last sited 5-13-75
9	♀ adult	6-17-74 Wig Creek	Radio (PVC pipe) w/tan tape	6947-A	6948-A	Last sited 5-13-75

---

[1] Age as of May 1975 or when shot.
[2] Partial acrylic radio collar (Zahn 1974).
[3] Two plastic identification flags in a series of 7 flags.
[4] Solid acrylic radio collars (Denton 1973).
[5] Animal recaptured on 4-5-74, old solid acrylic collar replaced, became Elk B.

During winter, habitat types receiving heaviest use by elk were Douglas fir/bluebunch wheatgrass, Douglas fir/elk sedge, Douglas fir/snowberry, and Douglas fir/ninebark. In spring, use decreased on the Douglas fir/bluebunch wheatgrass and Douglas fir/elk sedge types and increased on the Douglas fir/beargrass type. Most observations of elk during summer and fall were made in the Douglas fir/beargrass and Douglas fir/ninebark types. Few observations were made in subalpine fir types.

Bohne found some elk use of logged areas at lower elevations during winter and spring. There was considerable summer elk use at the terraced pine plantations near the head of Burdette Creek for feeding. These are on old burns and provide good browse, grass, sedge, and forb forage. Some bulls also used the Lupine Creek terraced areas in winter. During late summer and early fall, elk were found mostly in unlogged, heavily timbered areas, and they made little use of logged areas with extensive road systems. Heavy snowfall in October and November moved elk into logged and open areas where they were more easily killed by hunters. Hunting pressure soon pushed the elk into less-accessible, heavily-timbered areas. Bohne recognized the importance of these escape areas to the elk population and speculated about adverse affects of proposed timber sales. He recommended that: 1) The Burdette and Lupine Creek drainages not be roaded or logged, and that proposed timber sales in adjacent drainages be broken down into smaller sales. 2) The adjacent large drainages be logged at least 10 years apart to allow for regeneration on the logged areas and to give the animals time to adjust to changes in their habitat. 3) Road systems be kept to a minimum without inter-connections, and some main system roads and most spur roads be closed when logging is completed.

Lemke (1975) made further observations on habitat-type use which will be discussed in the 1975 annual report.

LITERATURE CITED

Bohne, Joseph R. 1974. Food habits, seasonal distribution, and habitat utilization of elk in the South Fork of Fish Creek, Lolo National Forest, Montana. Unpub. M.S. thesis, University of Montana, Missoula. 187 pp.

Lemke, Thomas O. 1975. Data from unfinished M.S. thesis on Burdette Creek elk study. University of Montana, Missoula.

Lyon, L. Jack. 1973. Cooperative elk-logging study. Job II-A, Burdette Creek-Deer Creek vegetation analysis: pp 7-25. Progress Report for Jan. 1-Dec. 31, 1972. Forest Sciences Lab. University of Montana, Missoula. 172 pp.

Zahn, Helmut M. 1974. Seasonal movements of the Burdette Creek elk herd. Unpub. M.S. thesis, University of Montana, Missoula. 71 pp.

Submitted By: Reuel Janson

JOB II-B

LONG TOM CREEK STUDY

PROGRESS REPORT FOR THE PERIOD
January 1, 1974-December 31, 1974

INTRODUCTION

The objectives of this study are to determine the environmental requirements of elk and the impact of logging on an elk population in the scattered forest type of Long Tom Creek in Southwestern Montana. Field work was conducted from June-November each year, 1971-1974. Fourteen clearcuts ranging from 17 to 106 acres and averaging 44.3 acres in size are planned for the area (Fig. 1). Also scheduled is 3.9 miles of road reconstruction and 9.5 miles of new road construction. The road reconstruction has been completed and approximately 3.5 miles of new road construction was completed during the fall of 1973 and an additional 2 miles were partially completed during the summer of 1974. Due to the suppressed timber industry, present plans are to complete the new road construction by the fall of 1975 and begin logging in the southern portion of the study area during spring, 1975. Logging should be complete by the end of fall in 1976. The new road has a gate near its beginning and will be closed to motorized public access for at least the duration of the study.

Description of the Study Area

Long Tom Creek, located about 25 miles southwest of Butte, Montana, is a side drainage of Jerry Creek which flows southerly and empties into the Big Hole River near the village of Wise River (Fig. 2). Elevations range from 7,000 to 9,100 feet with the Continental Divide forming the north boundary of the study area. The Long Tom Creek-Upper Johnson Creek study area comprises about 36 square miles and is mostly timbered. A variety of timber and habitat types are represented, to include lodgepole pine, Douglas-fir, subalpine fir, whitebark pine, Engelmann spruce, and combinations there of dominant overstory species. The area is interspersed with numerous small, wet sedge meadows and bogs, parks, rocky ridges and open, south-facing sagebrush and grasscovered slopes. Clearcut logging has occurred in the head of Jerry Creek to the east and in Lower Johnson Creek to the south and southwest. The only public vehicle access to the area is by 4-wheel drive from the east and northeast during periods of relatively dry road conditions. The study area is a portion of Hunting Unit 319 and is mostly on the Beaverhead National Forest with a small portion to the north located on Deerlodge National Forest land.

METHODS

As in 1972 and 1973, summer and fall elk distribution was determined in 1974 primarily from "elk sign" observed while periodically and systematically walking approximately 62 miles of foot routes. The 11 established

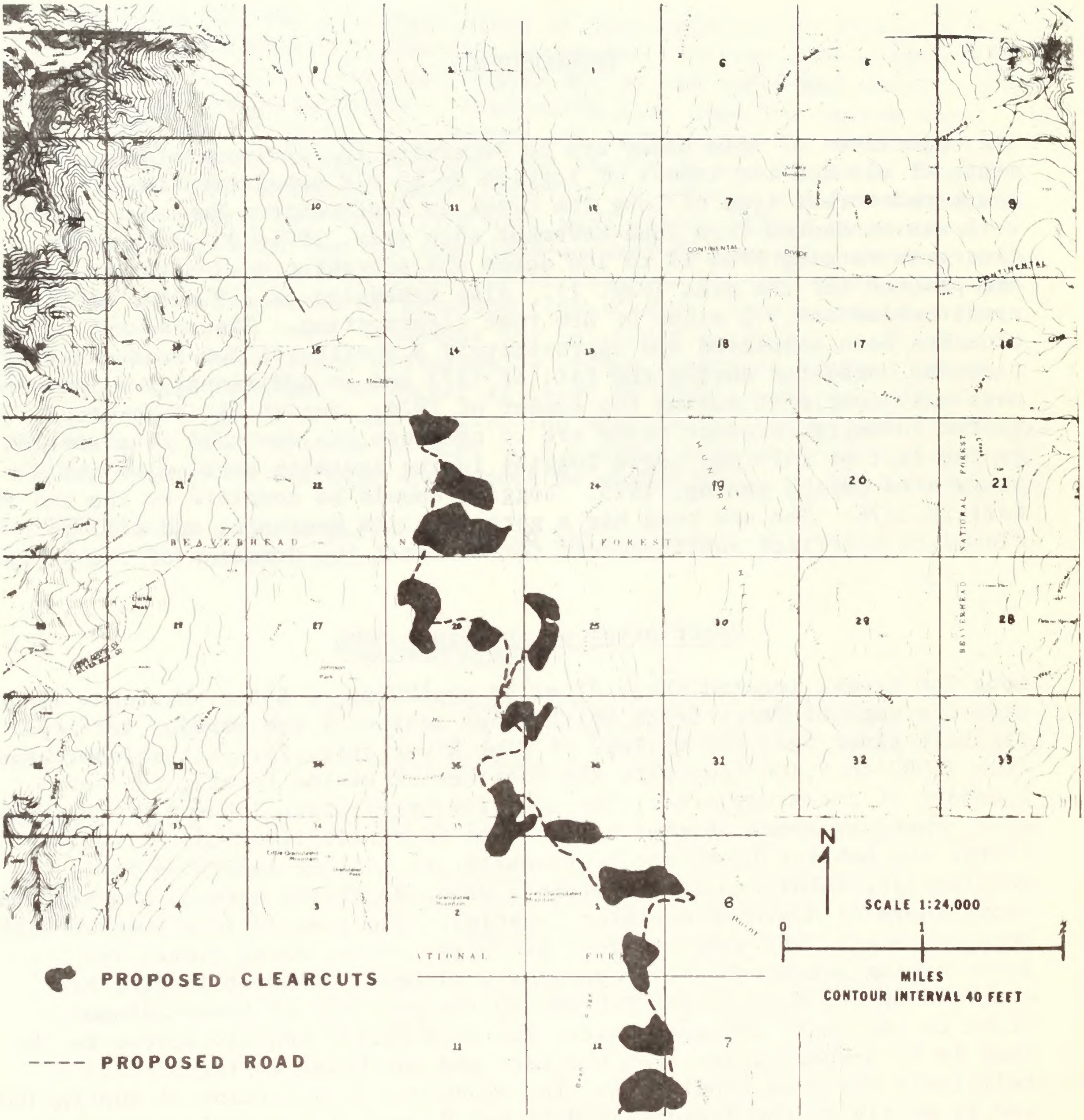

PROPOSED CLEARCUTS
---- PROPOSED ROAD
N
SCALE 1:24,000
0
1
2
MILES
CONTOUR INTERVAL 40 FEET
CONTINENTAL DIVIDE
BEAVERHEAD NATIONAL FOREST
HUNGRY
6
7
8
10
11
17
18
19
20
21
28
29
30
31
32
33

Figure 1. Proposed clearcuts and main road construction.

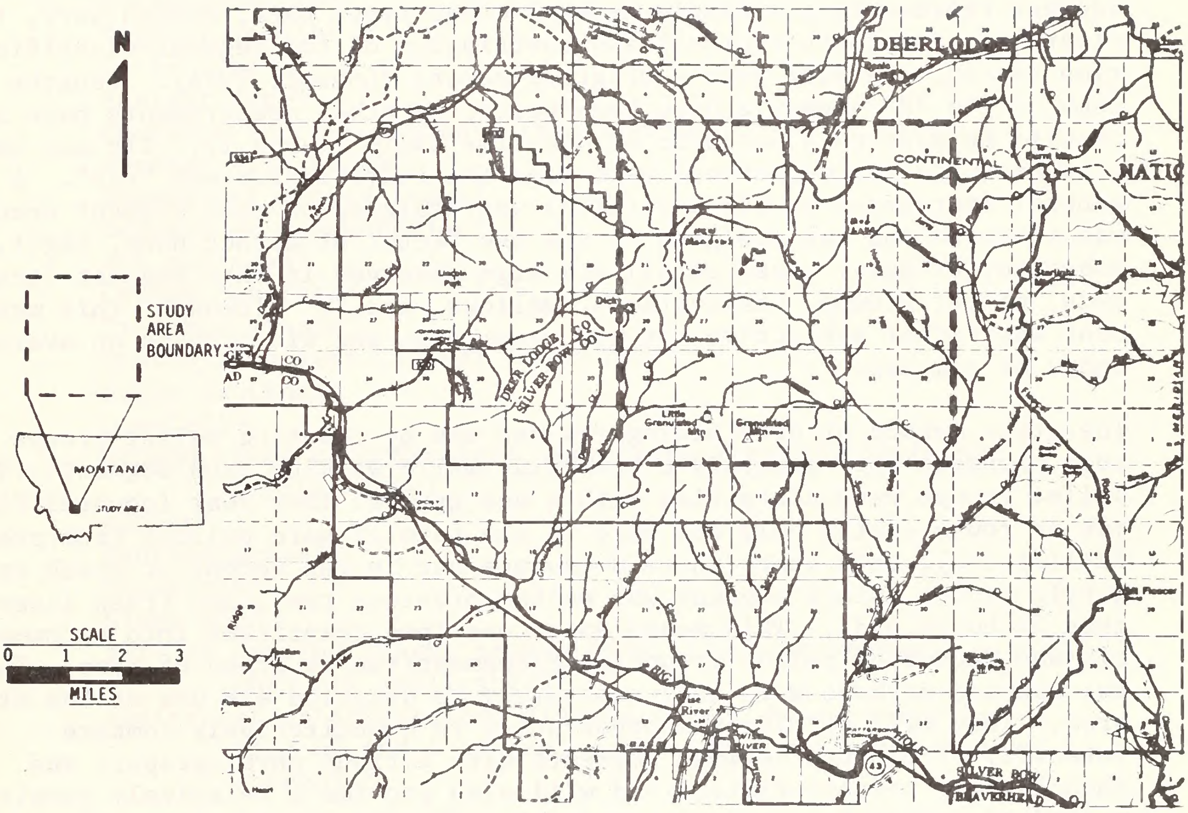

N
STUDY AREA BOUNDARY
MONTANA
STUDY AREA
SCALE
0 1 2 3
MILES
DEERLODGE
CONTINENTAL
NATIO
DEER LODGE CO
SILVER BOW CO
Little Granulated Mtn
Granulated Mtn
Wise River
BIG HOLE
43
SILVER BOW
BEAVERHEAD

Figure 2. Vicinity of Long Tom Creek Study Area.

foot routes were each walked 7 times (June 19 - October 30). The time interval between each "run" was approximately 3 weeks. During 1972, each route was walked 4 times (August 1 - November 9). In 1973, comparatively mild winter and spring weather conditions allowed us to begin walking routes on June 5, while comparatively severe weather conditions prevented any routes to be walked after October 31.

The eleven foot routes were established in 1972 with minor revisions made in 1973. They range from approximately 3.0 to 9.0 miles in length and average 5.6 miles. Each route has been divided into segments with each segment representing a single general cover type; park, broken park, timber, clearcut. For further detail and description of the segment classification system, see last year's progress report (Lonner, 1974). Lengths of each of the 700 segments have been paced; 28 other measurements have been or will be made on a periodic or one-time basis (Table 1). Elk use has been measured by two methods each time the route system was "run". A general impression of elk use (GIEU) was assigned to each segment when it was surveyed and was assigned an elk use factor of either none, light, moderate, or heavy based on all elk sign observed in that segment (tracks, beds, pellet groups, observations, wallows, etc.). Although this measurement was rather subjective, it was consistent and did provide an overall index of elk use.

The other method of determining elk use was by counting pellet groups in a belt transect approximately 6 feet wide while walking each segment. The pellet groups were classified into 4 age groups; last year (counted first run of route system only and were in the form of hard pellets from previous fall(s) use), this year (those droppings not in the recent or fresh category), recent (since segment was walked previous run), and fresh (less than 24 hours old). This measurement was then quantified into a common elk use factor of pellet groups/pace/segment/run or group of runs. These two elk use methods were used separately to describe elk use of the study area. They will provide the opportunity to quantitatively compare intensity of elk use between segments with various physiographic and phenological characteristics and will also provide a relatively sensitive method of describing not only seasonal shifts in elk distribution, but yearly shifts as well. A linear correlation analysis between these two elk use measurement methods for the summer and fall seasons in 1972 through 1974 showed a statistically significant relationship. The correlation coefficients ranged from 0.72 to 0.93 (Table 2).

To define and describe elk distribution, the study area has been divided into 16 subdivisions. These divisions were based on a combination of general topographical and morphological features, and general homogeneity of each sub-divided area. Each of the 16 areas includes a portion of the foot route system (Fig. 3). For further detail and description of the sub-divided areas see last year's progress report.

Radio telemetry was again used in an attempt to gather detailed data on elk movements and distribution in and between the study area and the

Table 1. List of 28 measurements for each of the 700 segments composing the 62 mile foot route system in the Long Tom Creek study area.

Elk use (pellet groups categorized into last year, this year, recent, and fresh; and general impression of elk use)[1]
Deer use (pellet groups, observations, tracks)[1]
Cattle use (droppings per pace, observations, tracks)[1]
Forage use[1]
Wetness type[1]
Wetness degree[1]
Segment length[2]
Cover type[2]
Habitat type[2]
Dominant and sub-dominant tree species[3]
Average tree height[3]
Density of mature trees[3]
Density of regeneration[3]
dbh averages[3]
Canopy coverage[2]
Tree age sample[3]
Distance to next closest cover type[4]
Sight distance[2]
Downfall[2]
Ground cover or understory vegetation (largely explained by habitat type)
Aspect[2]
Configuration[2]
Topography[2]
Slope (%)[2]
Size of opening (park, broken park, clearcut) segment passes thru (if applicable)[2]
Indices of interspersion, diversity, and homogeneity for each of the 4 general cover types and combinations thereof.[4]

---

[1] Measured each time segment is surveyed (all others only measured once).
[2] Measurements are completed.
[3] Measurements are approximately 25 percent completed.
[4] Measurements will be made as explained in the 1973 progress report.

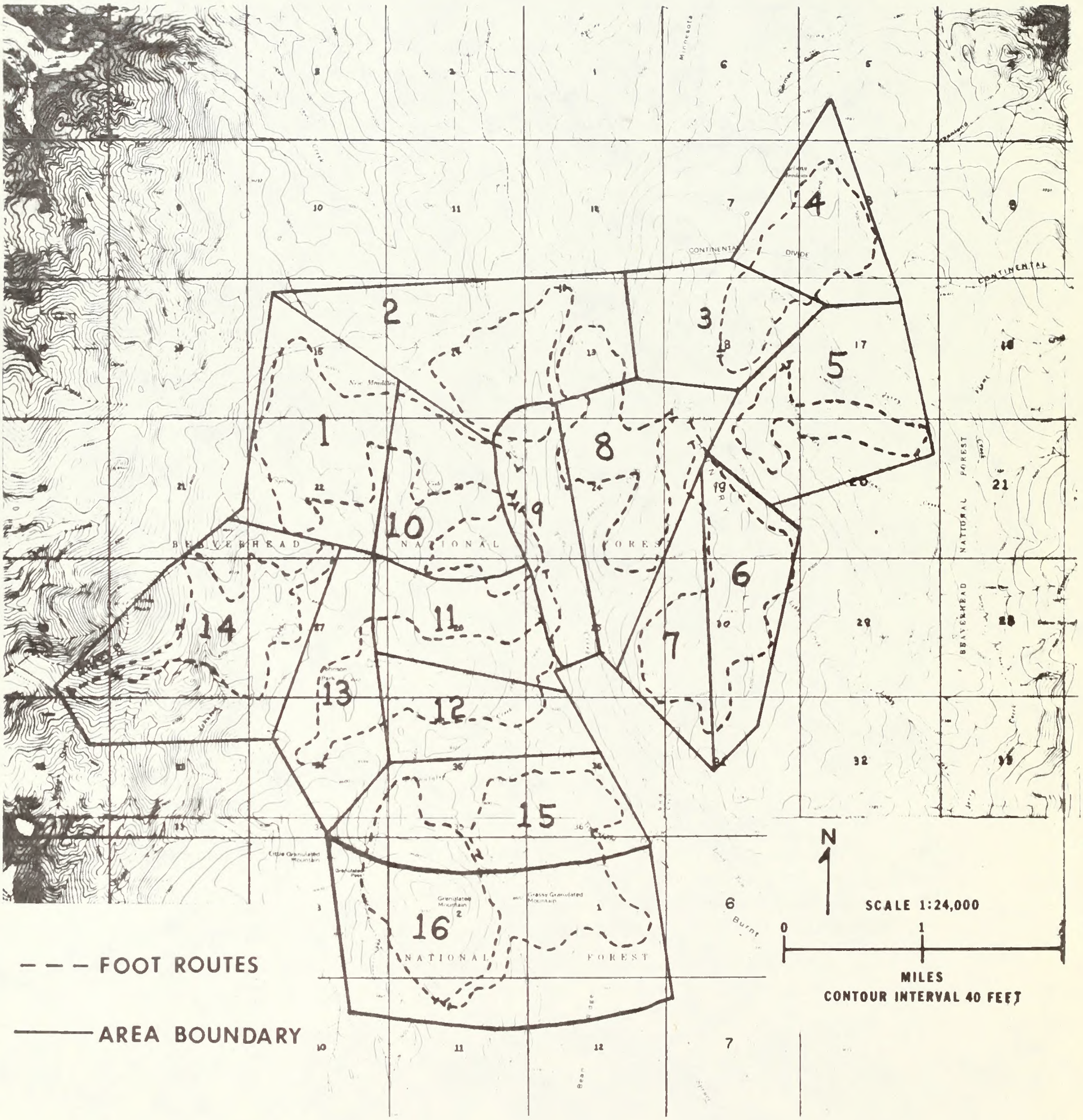

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
19
CONTINENTAL
DIVIDE
BEAVERHEAD
NATIONAL
FOREST
NATIONAL FOREST
BEAVERHEAD NATIONAL FOREST
N
SCALE 1:24,000
0
1
MILES
CONTOUR INTERVAL 40 FEET
FOOT ROUTES
AREA BOUNDARY

Figure 3. Subdivided areas and established foot routes.

Table 2. Correlation between the pellet group elk use method and the general impression elk use method.[1]

Season	Year	Correlation Coefficient[2]
Summer	1972	.98
	1973	.83
	1974	.72
Rut	1972	.93
	1973	.88
	1974	.92

---

[1] Correlation analysis based on comparing elk use measured by both methods in each subdivided area.

[2] All correlation coefficients are significant at P = .01.

Fleecer-High Rye winter range area. All transmitters were put on using a helicopter and capture gun.

Hunter check station questionnaires were filled out on opening day of the general big game season at 6 check stations located near the Long Tom Creek study area. Similar surveys were conducted in 1972 and 1973 and will be continued throughout the study. Although very limited, this information should provide a trend index on hunting pressure, elk harvest, and elk seen within and adjacent to the study area.

Time lapse photography was again used in the study and initially involved 4 cameras during the 1974 field season. One camera malfunctioned in June and was removed from the study area for the rest of the field season and another camera was stolen either the latter part of September or the first two weeks in October. The cameras were rigged to take pictures every 4 or 6 minutes, 24 hours a day. New timing actuators have been purchased and will be used on 3 cameras during the 1975 field season. This device can trigger the camera (1 frame at a time) from a 1 second interval to a 256 minute interval, in powers of 2, with or without a photocell in the circuit. With the photocell employed the camera will not take pictures at night. This technique has proved to be a very worthwhile tool in objectively measuring elk use of specific areas (natural and artificial openings.

Permanent vegetation plots were established in 6 of the 14 proposed clear-cut units during the 1974 field season. Two 25-meter transects were laid out in each clearcut unit in such a way that neither the contour nor the fall-line were sampled. Field methods are discussed in detail in the 1973 progress report (Lyon, Burdette Creek-Deer Creek Vegetation Analysis, pp. 12-15). The remaining clearcut units not measured are scheduled to be measured during the 1975 field season. Also scheduled to be measured for all proposed clearcut units during the 1975 field season is elk use in and adjacent to each unit. Twenty-four of possibly 30 road crossing transects were established perpendicular to approximately 7 miles of the proposed logging road. These cross transects are presently laid out approximately every 1/4 mile and 200 yards (paces) perpendicular to each side of the road. Elk use, both general impression and pellet group counts, was recorded at 50 yard intervals for each 200 yard transect on both sides of the road. Elk use of both the clearcut areas and area adjacent to the road will be measured the latter part of August each year for the duration of the study and should provide information about elk response to this habitat alteration and its associated human activity.

FINDINGS AND DISCUSSION

Elk Distribution

The study area is used primarily as elk summer and fall range, generally between June 15 and mid-November dependent upon weather conditions and snow depths. Elk use of the study area was evaluated on a seasonal basis from June through August (summer season), September through early October (rutting season), and early October through late October-early November (first third of hunting season) for 1972, 1973, and 1974. Elk use of the study area during the fall (September through November) for 1971, 1972, and 1973 was also evaluated. This was accomplished by recording elk pellet groups by age class "last year or older" along the route system during the first runs of the 1972, 1973, and 1974 field seasons. The distribution of elk use for each of these 4 seasonal categories was defined by the 16 subdivisions as presented in Figure 3. There is limited data on elk use for the summer season of 1972, since the first time the route system was walked during that year was in August. Elk use for the 1973 and 1974 summer seasons was sampled by making 4 runs of the route system during June-August each year. Elk use for the breeding season (rut) was sampled by 2 runs of the route system during that period and the last run of the route system was used to evaluate elk use during the first third of the hunting season for each year 1972 through 1974.

The distribution of elk use within the study area as defined by the 16 subdivided areas for the seasonal categories was quite varied between areas for all 3 years. A three factorial interaction analysis showed this variation of elk use between areas for all 3 years for both elk use methods to be statistically significant (P = .05) (Table 3). The overall variation of elk use between years and within areas between years was not significant during the summer and breeding season for either elk

Table 3. A summary of factorial interaction analysis to help define differences of elk distribution within the Long Tom Creek Study area for 1972-1974.

	Summer Season				Rutting Season				Fall Season	
Source of	Elk Use Method[1]				Elk Use Method				Elk Use Method	
Variation	PG		GIEU		PG		GIEU		PG ("last year")	
	F-values[2]		F-values		F-values		F-values		F-values	
	FC	FT	FC	FT	FC	FT	FC	FT	FC	FT
Subdivided Areas	3.51*	2.02	2.15*	2.02	2.03*	2.02	2.32*	2.02	2.10*	2.02
Year	1.30	3.32	.61	3.32	3.13	3.32	3.30	3.32	5.35*	3.32
Area-year[3] Interaction	.90	1.84	.78	1.84	1.50	1.84	1.07	1.84	-[5]	-
Area-year[4] Interaction not Adjusted	.92	1.82	.77	1.82	1.60	1.82	1.21	1.82	-	-

[1] PG= pellet group method; GIEU = General Impression elk use method.

[2] F= F distribution values; FC = F calculated and FT = F from table value (Snedecor and Chochran 1967. Statistical methods. pp. 564-567).

[3] Year to year interaction within subdivided areas and adjusted for overall elk use in study area.

[4] Year to year interaction within subdivided areas and not adjusted for overall elk use in the study area.

[5] Interaction analysis not valid based on existing data.

*significant at P = .05.

use method, although there were some significant differences of elk use within individual areas between years (Figs. 4-7). Elk distribution within the study area and measured only by the general impression of elk use method during the 1st third of the hunting season for all 3 years was so varied that its interpretation was highly questionable. This occurred primarily because of snowstorms that could have either under or over emphasized elk sign while the last run of the route system was made each year. The distribution of elk use within the study area for the fall of 1971, 1972, and 1973 as defined by the "last year" pellet group count showed significant variation between areas and between years. Over 50 percent of the significance tests for mean elk use during this season within areas between years showed a significant difference (Fig. 8). Although a percentage of the pellet groups persisted 2 to 3 years or more, this overlap was apparently not large enough to significantly mask the year to year variation of elk use recorded for this time period.

A significant seasonal shift in elk use between the summer and rutting seasons for all 3 years occurred in no more than 5 and not less than 3 of the subdivided areas for any given year and elk use method (Fig. 9). The shifts were not consistent within areas between years. Since the summer elk use data for 1972 is so limited (based on one run of route system in August) this probably accounts for some of the inconsistency. For both 1973 and 1974 and both elk use methods, a unanimous shift of elk use away from areas 1, 2, 8, 13, 14, and 16 occurred from the summer to the rutting season; this shift was statistically significant in areas 1, 8, and 14. A unanimous, but not significant, shift of elk use into area 10 occurred between these same two seasons. Most of these shifts can be attributed to rutting behavior, changes in forage use preferences, and livestock grazing influences. It should also be noted that for both 1973 and 1974, and both elk use methods, the overall mean elk use of the route system declined during the rutting season.

These data and analyses should provide an adequate pre-logging data base for comparison with elk distribution and use of the study area measured during and after the logging operation.

Elk use-habitat type relationships

The integrity or combination of interspersion, diversity, and juxtaposition of various habitat types and their successional stages or cover types cannot be overemphasized as an important characteristic of elk habitat. When an attempt is made to quantify elk use-habitat type relationships it is very difficult to differentiate between the importance of individual habitat types and the overall interrelationships of these types with one another. Individual habitat (cover) type-elk use comparisons have to be made to at least "red flag" those types within the complex forest ecosystem that appear to be important or key areas for elk. A further measurement of the overall interrelationships of these types relative to elk use intensities would strongly refine our understanding of the ecological requirements of elk while on summer and fall range.

Subdivided Areas

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1972-73	N	N	N	N	N	S	N	N	N	N	N	S	N	N	S	N
1973-74	S	N	N	S	N	S	N	S	N	N	N	N	N	N	N	N
1972-74	N	N	N	N	S	N	N	S	N	N	N	S	N	N	S	N

Significance Table (P = .05)
N = No significant difference between years
S = Significant difference between years

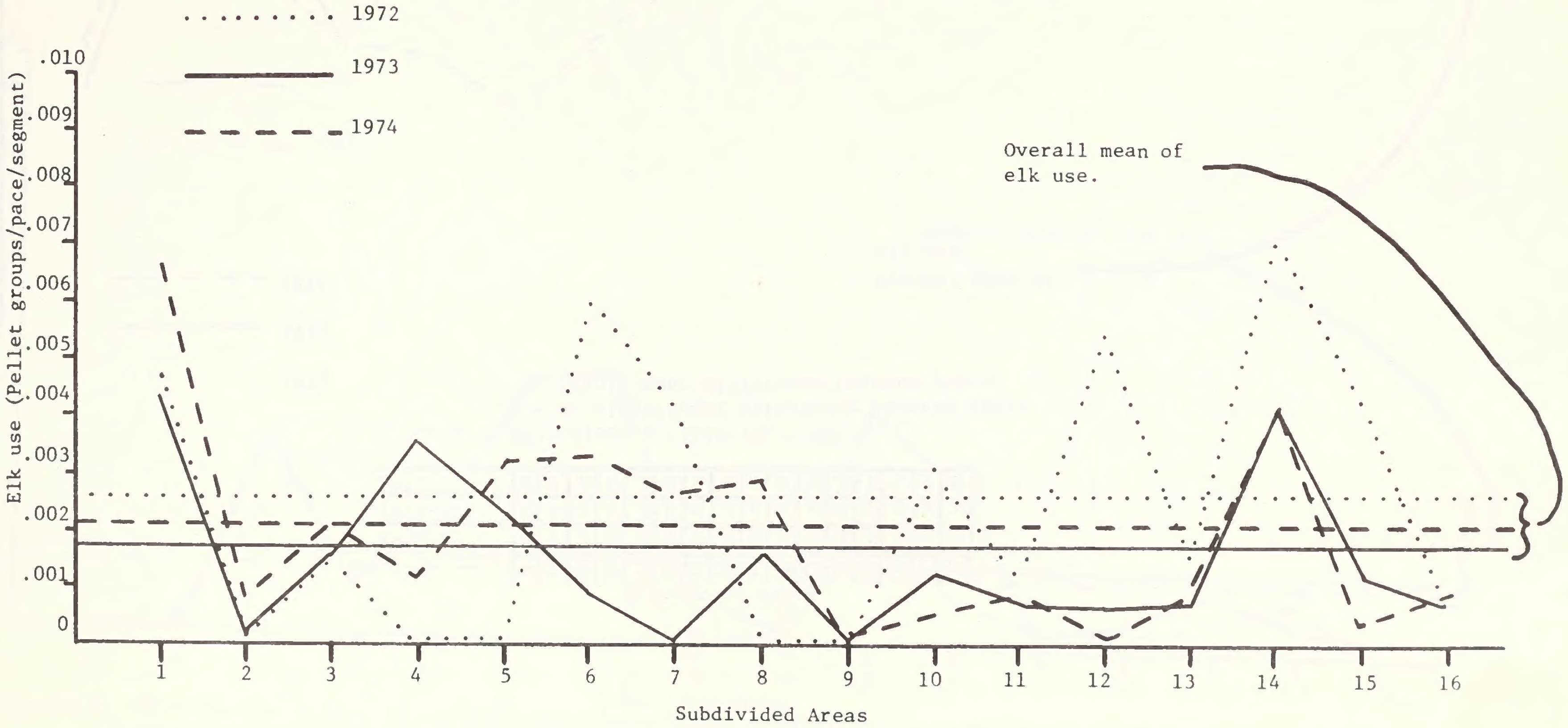


Figure 4. Distribution of elk use (Pellet groups/pace/segment) within the Long Tom Creek Study Area for the summer season of 1972 through 1974.

	Subdivided Areas															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1972-73	N	N	N	N	S	N	S	S	N	N	N	S	N	S	S	N
1973-74	N	N	S	N	S	N	S	S	N	N	N	S	N	N	N	N
1972-74	N	N	S	N	S	N	N	S	N	N	N	S	N	S	S	N

Significance table (P = .05)
N = No significant difference between years
S = Significant difference between years

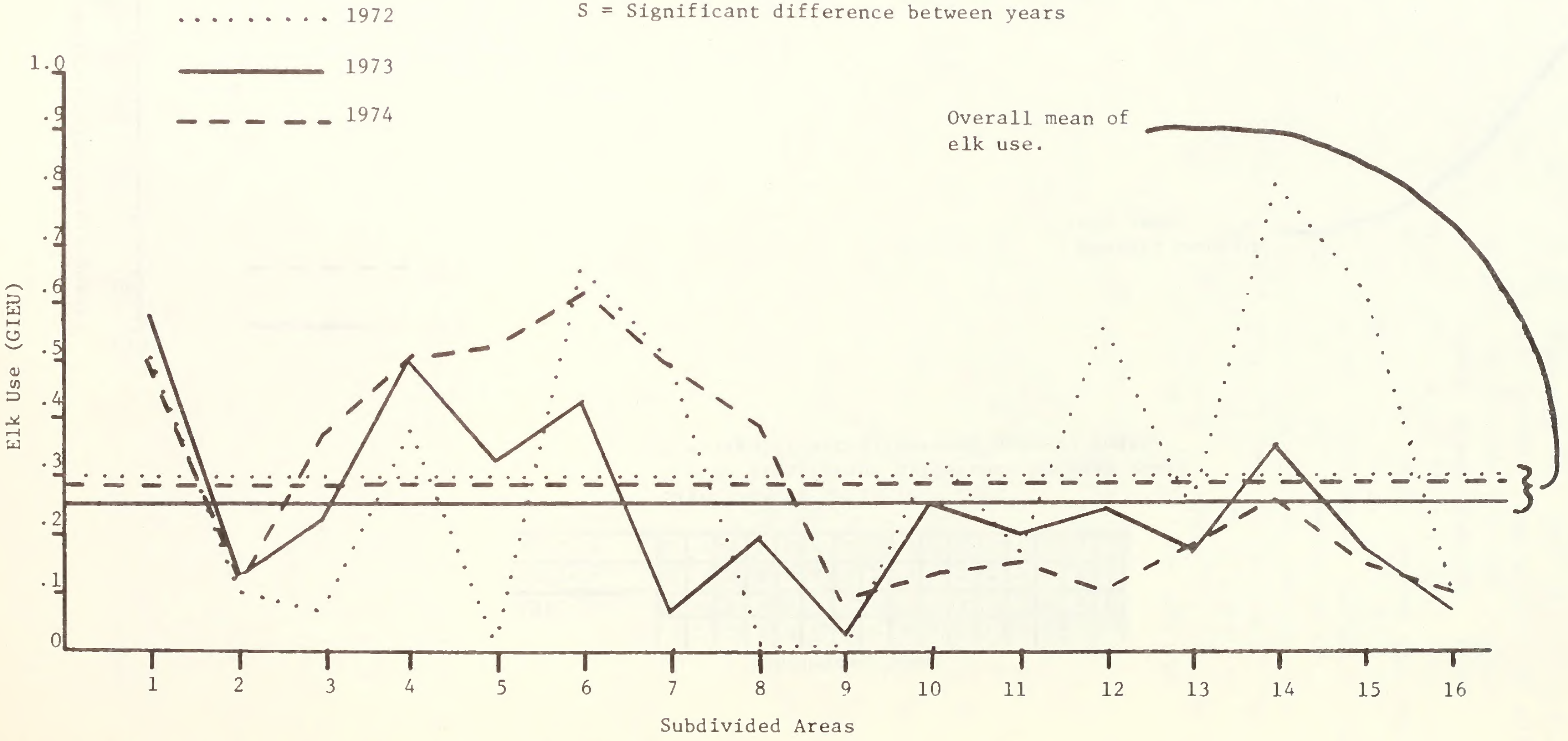


Figure 5. Distribution of elk use (GIEU) within the Long Tom Creek Study Area for the summer season of 1972 through 1974.

	Subdivided Areas															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1972-73	N	N	N	N	N	N	N	N	N	N	N	N	N	S	S	S
1973-74	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1972-74	N	N	N	N	S	N	S	N	N	N	N	N	N	S	S	S

Significance table
N = No significant difference between years
S = Significant difference between years

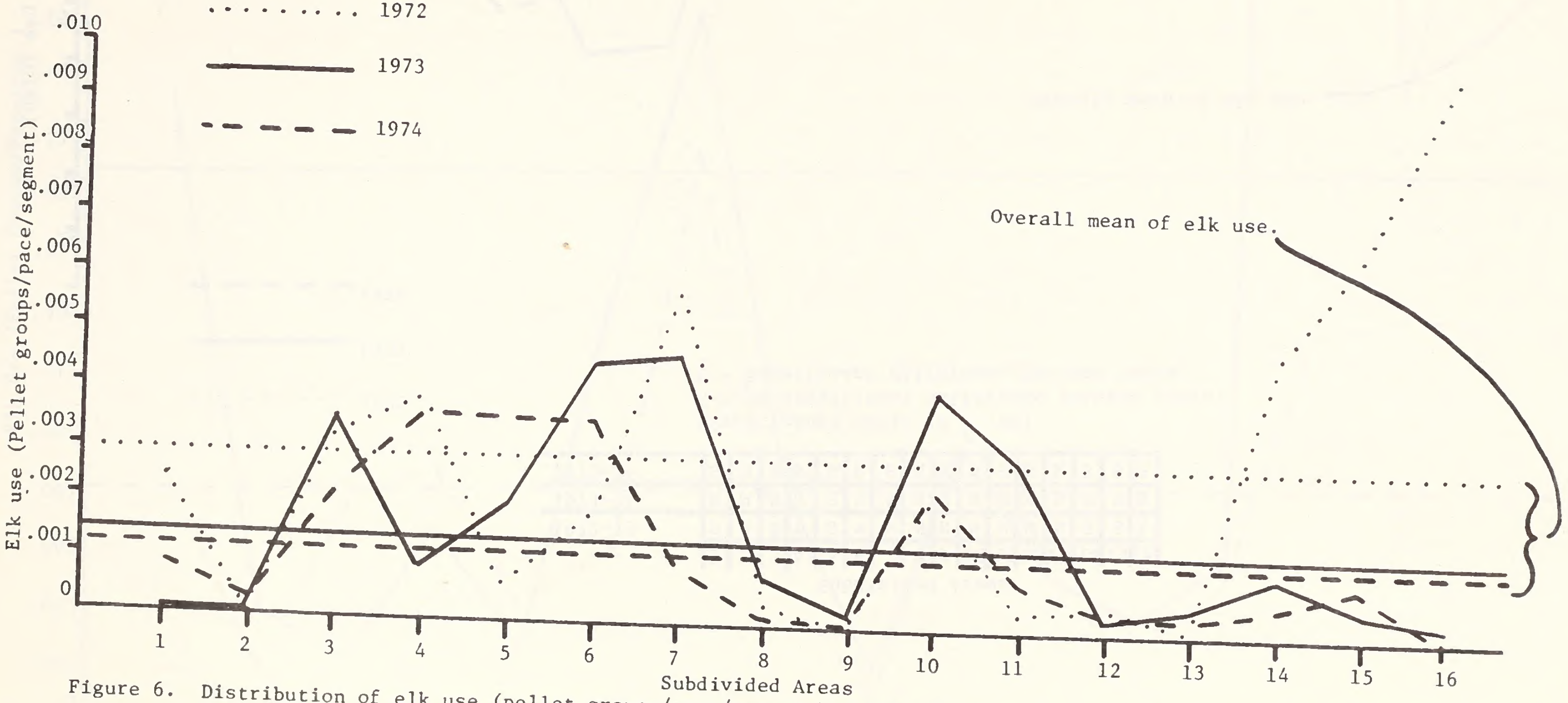


Figure 6. Distribution of elk use (pellet groups/pace/segment) within the Long Tom Creek Study Area for the rutting season of 1972 through 1974.

Subdivided Areas

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1972-73	S	N	N	N	S	N	N	N	N	N	S	N	N	S	S	S
1973-74	N	N	N	N	S	N	N	N	N	N	N	N	N	N	N	N
1972-74	S	N	N	N	S	N	S	N	N	N	N	N	N	S	S	S

Significance table (P = .05)
N = No significant difference between years.
S = Significant difference between years.

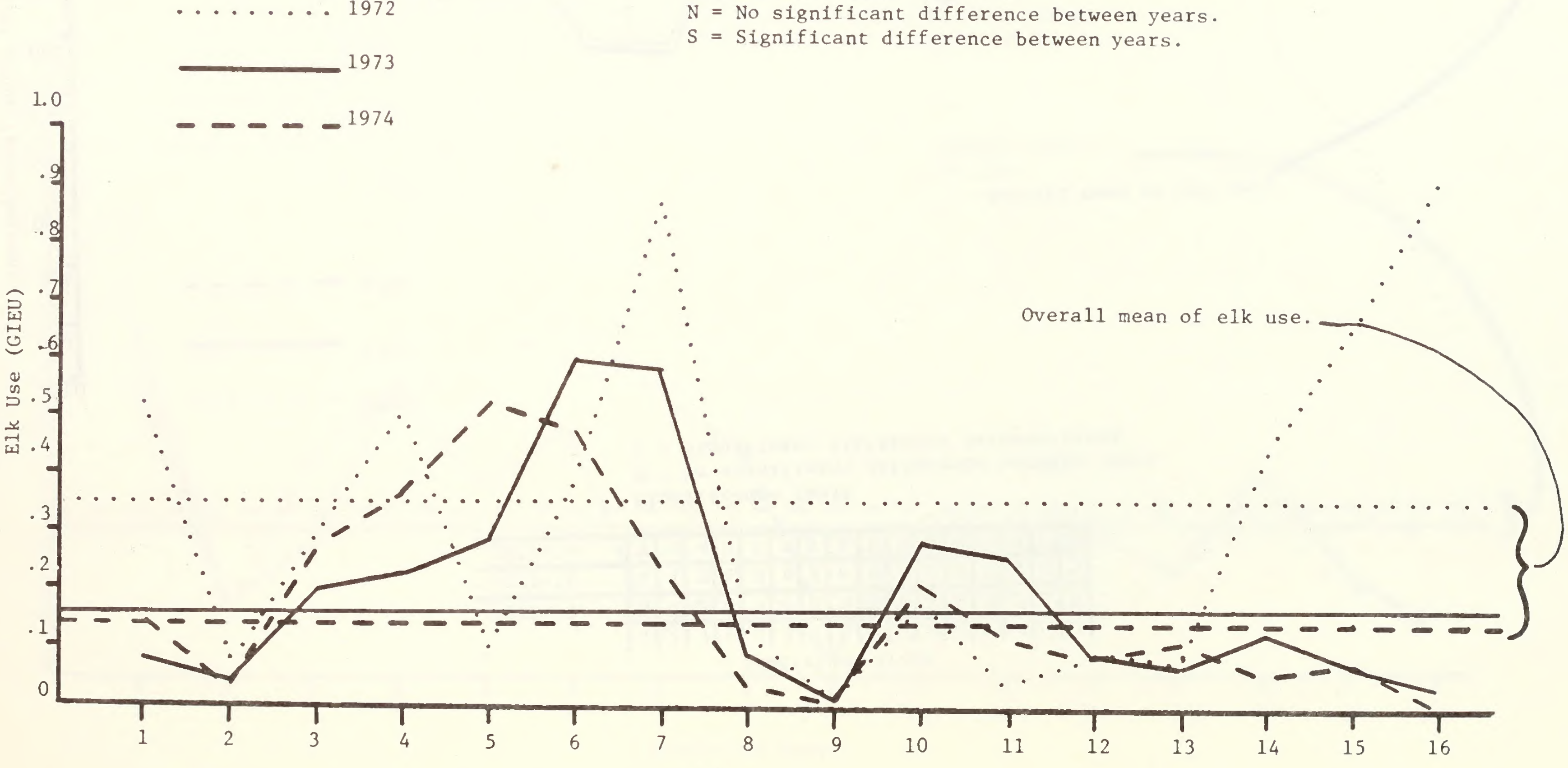
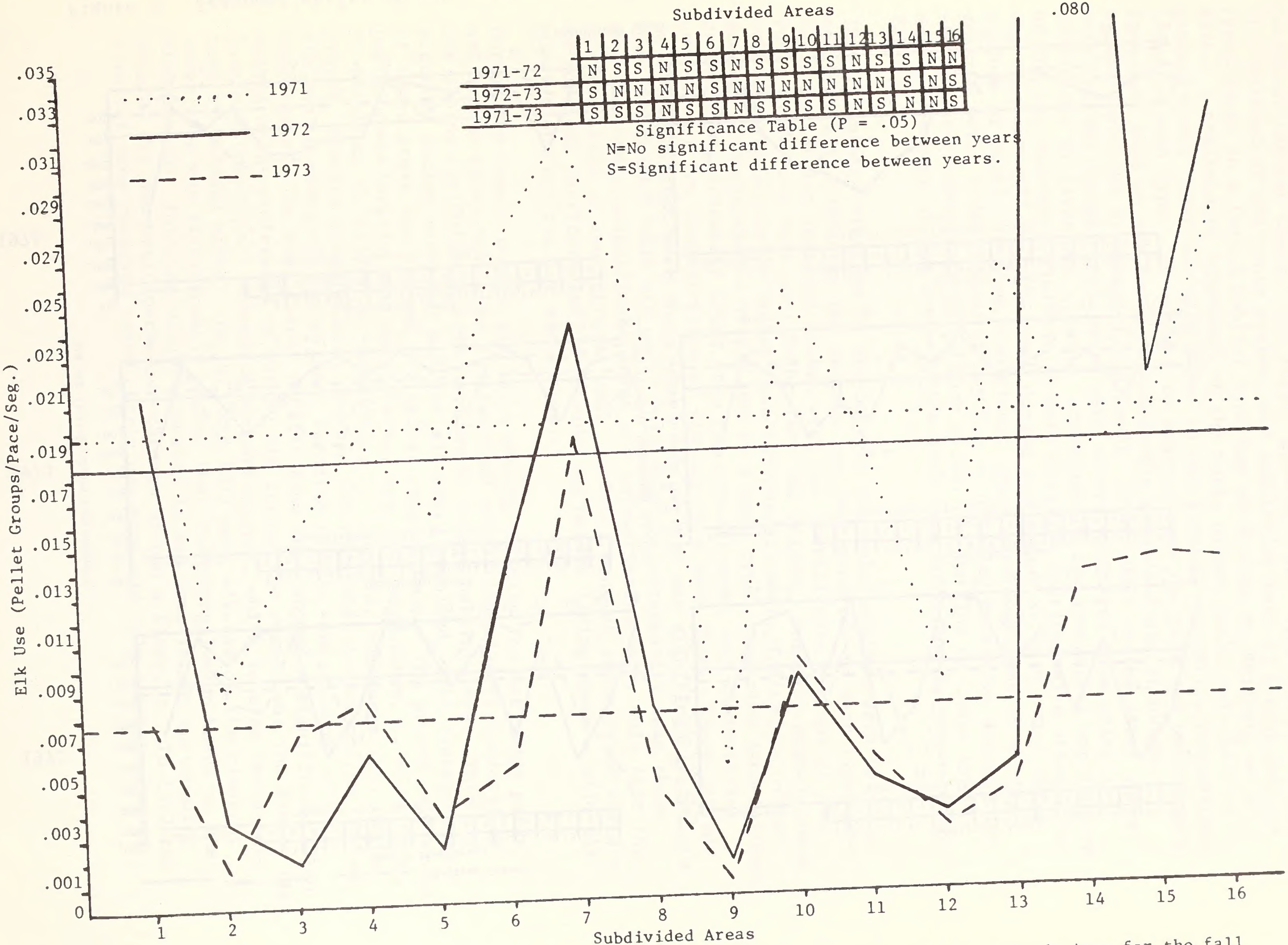


Figure 7. Distribution of elk use (GIEU) within the Long Tom Creek Study Area for the rutting season of 1972 through 1974.



Subdivided Areas

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1971-72	N	S	S	N	S	S	N	S	S	S	S	N	S	S	N	N
1972-73	S	N	N	N	N	S	N	N	N	N	N	N	N	S	N	S
1971-73	S	S	S	N	S	S	N	S	S	S	S	N	S	N	N	S

Significance Table (P = .05)
N=No significant difference between years
S=Significant difference between years.

Figure 8. Distribution of elk use (Pellet Groups/Pace/Segment) within the Long Tom Creek Study Area for the fall

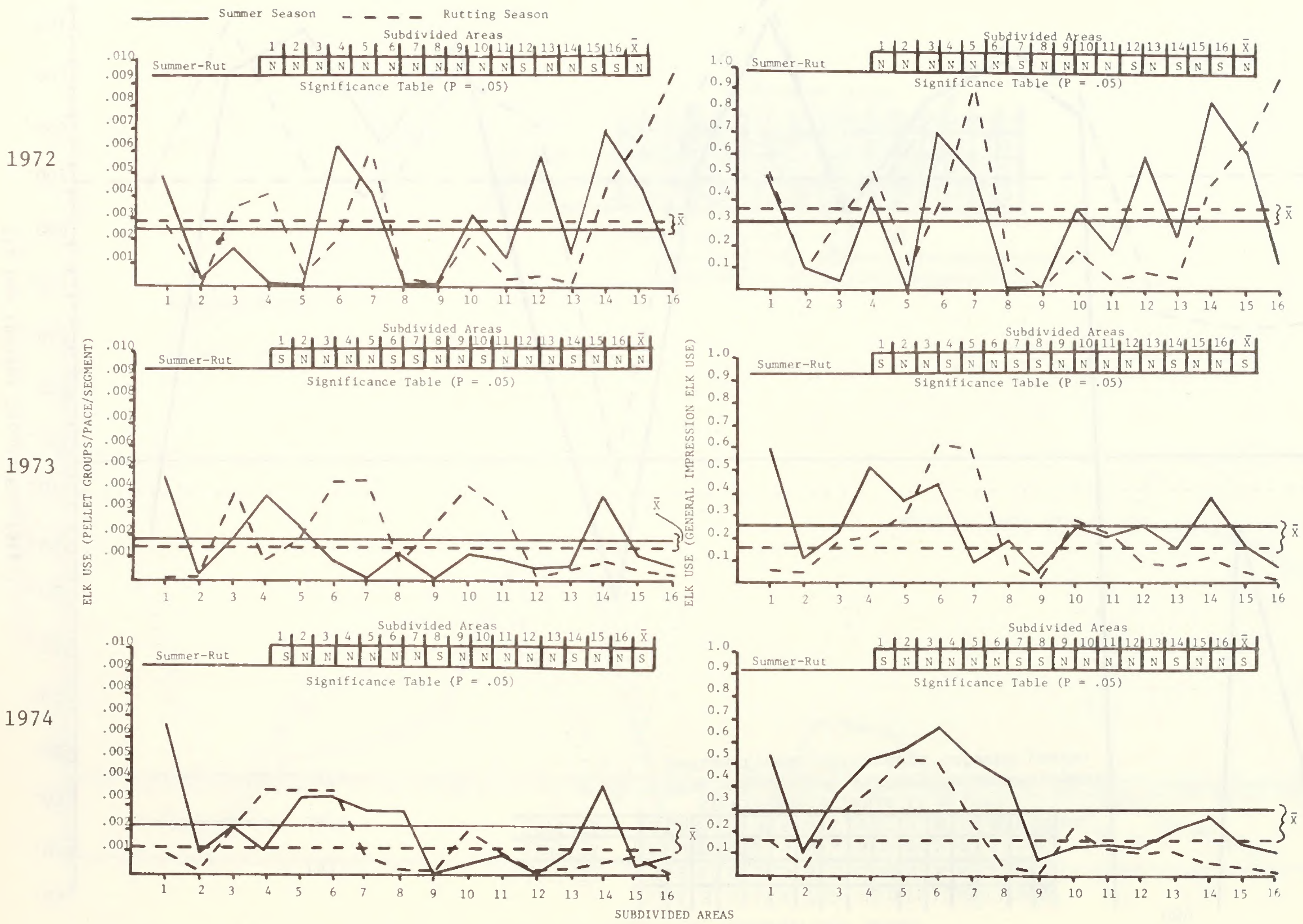


Figure 9. Seasonal shifts of elk use in the Long Tom Cr. study area as defined by the 16 subdivided areas.

The 4 general cover types in the route system were subdivided into vegetation or habitat types. The timber general cover type, which made up 51.3 percent of the route system, was subdivided into 13 forest habitat types based on a forest habitat type key of Montana by Pfister, et al. 1974. A preliminary breakdown of the park, broken park, and clearcut general cover types was made based on the general vegetative composition found in each type. An attempt to habitat type the park and broken park types was made on the basis of a mountain grassland and shrubland habitat type key by Mueggler and Handl, 1974. Most of the sites where this key was thought applicable were severely altered from pristine conditions by livestock grazing, consequently the successful application of the key was quite limited. A more detailed and intensive attempt to use this key will be made again during the summer of 1975. Wet sedge meadows or poorly drained, non-timber types were described in a very general way. I don't know of any key or detailed narrative description of vegetation associations on such sites. An outline of these types and the percent of the route system each type comprised is presented in Table 4.

The preliminary findings on elk-habitat use relationships were based on statistically comparing the average use that occurred in each type during a particular year and season with the overall mean elk use of the route system for that particular year and season. Positive associations, or means significantly higher than the overall mean, indicate a preference or a concentration of elk use in a said type. Negative associations, or means significantly lower than the overall mean, may indicate an aversion or low concentration of elk use in a said type. Types listed as nonsignificant were those where elk use did not significantly deviate from the overall mean elk use. This does not necessarily mean these aversion and nonsignificant types are unimportant to elk, only that they are not areas of concentrated use. In fact, many of these types may act as movement corridors and/or provide the needed living space a wild elk population requires for sustenance.

During the summer months elk had a strong affinity for wet sedge parks and broken parks that were interspersed and/or immediately bordered by the Alpine fir/*Calamagrostis canadensis* forest habitat type. This occurred during each year and for all years combined. The average size of these areas was 2.1 and 1.2 acres, respectively. The ground cover composition was largely made up of Carex, spp. *(C. scopulorum, C. microptera, C. luzulina, C. illota, C. aqualatic, C. rostrata,* and Carex spp. Ovales group), *Senecio triangularis, Senecio intergerimis, Arnica mollis, Phleum alpinum, Deschampsia Caespitosa, Veratrum viride,* and *Calamagrostis canadensis*. The only forest habitat type that showed a significant (GIEU method only) preference of use by elk during the summer was the Alpine fir/*Luzula hitchcockii - Vaccinium scoparium* type, which is also characterized by seepage areas. In 1973 and 1974 mean elk use of the clearcut cover type was significantly higher than the overall mean based on the GIEU method. This use occurred mostly in and immediately surrounding natural dry and mesic parks cut-through within a clearcut. In 1972 the clearcut area received heavy cattle use from mid July through most of

Table 4. General cover and habitat types and elk use relationships on the route system in the Long Tom Cr. study area for the summer season (June-August).

General Cover or Habitat Type

Significance Level

	P = .05	P = .01
Above overall average	+	++
Below overall average	-	--

NS = nonsignificant

General Cover or Habitat Type	Percent availability in Route System	Average size (area in acres)	1972				1973				1974				1972-1974			
			Elk Use and Z Value				Elk Use and Z Value				Elk Use and Z Value				Elk Use and Z Value			
			$\bar{X}$ = .0026		$\bar{X}$ = .3014		$\bar{X}$ = .0021		$\bar{X}$ = .2552		$\bar{X}$ = .0021		$\bar{X}$ = .2871		$\bar{X}$ = .0020		$\bar{X}$ = .2742	
			PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z
Dry Park (all)	15.3	6.1	.0022	NS	.21	-	.0019	NS	.17	--	.0026	NS	.27	NS	.0023	NS	.22	NS
Dry Park with *Festuca idahoensis* and/or *Agropyron spicatum* dominant	8.0	9.9	.0011	NS	.16	-	.0009	-	.15	--	.0021	NS	.27	NS	.0014	NS	.21	--
Dry Park often rocky and calcareous - mainly grasses and forbs present	1.6	3.8	0	NS	.08	NS	.0021	NS	.28	NS	.0017	NS	.35	NS	.0017	NS	.29	NS
Dry Park - grasses, forbs, and shrubs present	1.8	5.8	.0006	NS	.18	NS	.0006	NS	.07	--	.0037	NS	.23	NS	.0019	NS	.15	--
Dry Park - grasses and forbs present	3.7	2.1	.0050	NS	.32	NS	.0037	++	.21	NS	.0032	NS	.25	NS	.0036	++	.24	NS
Dry Park - very rocky (rockslide)	0.2	1.0	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	-
Wet Park (all)	9.4	2.1	.0039	NS	.48	++	.0024	NS	.35	++	.0040	++	.38	++	.0033	++	.38	++
Wet or mesic park	1.0	2.8	.0031	NS	.33	NS	.0007	NS	.18	NS	.0019	NS	.25	NS	.0015	NS	.23	NS
Wet sedge park with AF/caca interspersed and/or immediately bordering	8.4	2.1	.0040	NS	.50	++	.0026	+	.37	++	.0043	++	.40	++	.0035	++	.40	++
All Park Types	24.7	4.6	.0029	NS	.32	NS	.0021	NS	.25	NS	.0032	++	.25	NS	.0027	++	.28	NS
Dry Broken Park (all)	10.1	2.4	.0012	NS	.14	--	.0013	NS	.25	-	.0013	NS	.21	--	.0014	-	.20	--
Dry Broken Park often rocky and calcareous- mainly grasses and forbs present	1.8	4.4	.0007	NS	.18	NS	.0001	NS	.22	NS	0	NS	.05	--	.0015	-	.14	--
Dry Broken Park - grasses, forbs, and shrubs present	1.1	3.6	0	NS	0	NS	.0013	NS	.22	NS	.0009	NS	.19	NS	.0010	NS	.18	NS
Dry Broken Park - grasses and forbs present	7.2	1.8	.0015	NS	.16	-	.0015	NS	.18	--	.0016	NS	.25	NS	.0015	NS	.20	
Wet Broken Park (all)	11.4	1.4	.0030	NS	.48	++	.0028	++	.42	++	.0026	NS	.39	++	.0027	++	.41	++
Wet or mesic broken park	1.4	3.7	.0058	NS	.70	+	.0008	NS	.25	NS	.0023	NS	.30	NS	.0021	NS	.28	NS
Wet sedge broken park with AF/caca interspersed and/or immediately bordering	10.0	1.2	.0027	NS	.46	++	.0029	++	.44	++	.0026	NS	.40	++	.0028	++	.42	++
All Broken Park Types	21.5	1.8	.0023	NS	.34	NS	.0022	+	.33	++	.0021	NS	.33	NS	.0022	NS	.32	++

Table 4. Continued.

General Cover or Habitat Type Significance Level: P=.05 / P=.01 Above overall average: + / ++ Below overall average: - / -- NS = nonsignificant	Percent availability in Route System	Average size (area in acres)	1972 Elk Use and Z Value				1973 Elk Use and Z Value				1974 Elk Use and Z Value				1972-1974 Elk Use and Z Value			
			$\bar{X}$ = .0026		$\bar{X}$ = .3014		$\bar{X}$ = .0021		$\bar{X}$ = .2552		$\bar{X}$ = .0021		$\bar{X}$ = .2871		$\bar{X}$ = .0020		$\bar{X}$ = .2742	
			PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z
(AF = *Abies lasiocarpa*) AF/*Vaccinium scoparium*-*Vaccinium scoparium* phase	12.8	N/A	.0035	-	.42	+	.0008	-	.18	--	.0016	NS	.27	NS	.0015	-	.24	NS
AF/*Vaccinium scoparium*-*Thalictrum occidentale* phase	6.1	N/A	.0021	NS	.22	NS	.0020	NS	.17	--	.0008	-	.12	--	.0015	NS	.15	--
AF/*Vaccinium scoparium*-*Thalictrum occidentale* phase with AF/Caca interspersed	1.6	N/A	.0056	NS	.42	NS	.0011	NS	.19	NS	.0004	NS	.31	NS	.0013	NS	.27	NS
AF/(*Pinus albicaulis*)/*Vaccinium scoparium*	19.6	N/A	.0024	NS	.26	NS	.0014	NS	.24	NS	.0017	NS	.24	-	.0016	NS	.24	-
AF/*Vaccinium scoparium* - *Calamagrostis rubescens* phase	0.5	N/A	0	NS	0	NS	.0008	NS	.40	NS	.0005	NS	.50	NS	.0006	NS	.40	NS
AF/*Calamagrostis rubescens*	1.1	N/A	0	NS	0	NS	.0001	NS	0	NS	.0001	NS	0	-	.0001	NS	0	--
AF/*Luzula hitchcockii* - *Vaccinium scoparium* phase	1.5	N/A	.0031	NS	.44	NS	.0010	NS	.50	++	.0051	NS	.53	++	.0030	NS	.51	++
AF/*Menziesia ferruginea*	0.2	N/A	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS	0	NS
AF/*Calamagrostis canadensis* (often only a stringer)	1.8	N/A	.0031	NS	.11	NS	.0002	-	.14	-	.0008	NS	.19	NS	.0008	-	.16	--
AF/*Xerophyllum tenax* - *Vaccinium scoparium* phase	0.5	N/A	0	NS	0	NS	0	NS	.20	NS	0	NS	.50	NS	0	NS	.30	NS
Pinus albicaulis	4.6	N/A	.0009	NS	.10	NS	.0007	NS	.19	NS	.0012	NS	.26	NS	.0009	-	.21	NS
Pseudotsuga menziesii/*Juniperus communis*	0.6	N/A	.0034	NS	.50	NS	0	NS	.13	NS	0	NS	.13	NS	.0004	NS	.17	NS
Pseudotsuga menziesii/*Calamagrostis rubescens*	0.4	N/A	0	NS	0	NS	0	NS	0	-	.0025	NS	.25	NS	.001	NS	.10	-
Timber (all)	51.3	N/A	.0026	NS	.28	NS	.0012	--	.20	--	.0015	-	.24	--	.0015	--	.23	--
Clearcut - cut through timber	1.6	100	0	NS	0	NS	.0017	NS	.46	++	.0030	NS	.68	++	.0021	NS	.50	++
Dry Park-cut through within a clearcut	0.4	2.5	0	NS	0	NS	.0046	NS	.30	NS	.0068	NS	.75	++	.0050	+	.45	NS
Wet or mesic park - cut through within a clearcut	0.5	2.8	0	NS	0	NS	.0006	NS	.60	++	.0036	NS	.63	++	.0018	NS	.55	++
Clearcut (All)	2.5	N/A	0	NS	0	NS	.0018	NS	.48	++	.0038	NS	.67	++	.0024	NS	.51	++

Z = significance of standard normal deviate.
$\bar{X}$ = overall average of elk use for respective year and elk use measurement method.
PG = pellet groups/pace/segment.
GIEU = general impression elk use.

September and may have been the primary cause for little or no elk use recorded in that area during August and September for that year.

An aversion or low concentration of summer elk use was consistently significant between years for the dry broken park general cover type. This was also true for the timber general cover type with the Alpine fir/*Vaccinium scoparium-Vaccinium scoparium* phase, Alpine fir/*Vaccinium scoparium-Thalictrum occidentale* phases, Alpine fir/*Calamagrostis rubescens*, and Alpine fir/*Calamagrostis canadensis* (often only a stringer) forest habitat types contributing to most of this significant aversion. The general cover and habitat types and elk use relationships for the summer season during all 3 years are presented in Table 4.

A dramatic shift of elk use from wet sedge parks and broken parks during the summer to dry parks during the rut (September-early October) occurred all 3 years. The dry parks showing a significant increase in elk use were those with *Agropyron spicatum* and/or *Festuca idahoensis* as the dominant grass and those that were often rocky and calcareous with grasses and forbs as the dominant vegetation (Table 5). An increase in elk use of the timber general cover type during the rut was very apparent for all 3 years. In 1972 and 1973 this use was significantly above average in the Alpine fir/*Vaccinium scoparium-Vaccinium scoparium* type and in 1972 and 1974 significantly above average in the Alpine fir/*Luzula hitchcockii-Vaccinium scoparium* type. The clearcut general cover type, as during the summer months, received above average elk use during 1973 and 1974. Again, the dry and mesic cut-through parks accounted for most of this use with a shift from the mesic toward the drier cut-through park very evident (Tables 4 and 5).

Elk use of habitat and cover types during the fall (September through November) in 1971-1973 was similar to the elk use during the rut in 1972-1974. Although the dry park general cover type was still important during the fall, a difference in subtypes occurred. Dry parks with shrubs, grasses, and forbs and dry parks with grasses and forbs were important subtypes during the fall. There was a general aversion of all broken park types during the entire fall season for all 3 years separately and combined which was statistically significant (P = .01) except for 1973 (Table 6). The only significant elk use of timber habitat types during this time was a preferential use of the alpine fir/vasc-vasc and alpine fir (White-bark pine)/vasc types during the fall of 1973. No significant use (positive or negative) of the clearcut types occurred (Table 6).

Elk use - general physiographic relationships

Wetness Degree

As reported for the summer of 1973, mesic ground conditions during the summer of 1974 was again a strong characteristic of those sites that received concentrated elk use. Although there was variation of elk use intensity between 7 wetness degree categories within and between years, those segments classified as wet generally received more intense elk use

Table 5. General cover and habitat types and elk use relationships on the route system in the Long Tom Cr. study area for the rutting season (September-early October).

General Cover or Habitat Type Significance Level: P=.05 / P=.01 Above overall average: + / ++ Below overall average: - / -- NS = nonsignificant	Percent availability in Route System	Average size (area in acres)	1972				1973				1974				1972-1974			
			Elk Use and Z Value				Elk Use and Z Value				Elk Use and Z Value				Elk Use and Z Value			
			$\bar{X}$ = .0029		$\bar{X}$ = .3407		$\bar{X}$ = .0014		$\bar{X}$ = .1641		$\bar{X}$ = .0012		$\bar{X}$ = .1521		$\bar{X}$ = .0019		$\bar{X}$ = .2214	
			PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z
Dry Park (all)	15.3	6.1	.0043	+	.43	+	.0015	NS	.14	NS	.0019	+	.14	NS	.0023	NS	.24	NS
Dry Park with *Festuca idahoensis* and/or *Agropyron spicatum* dominant	8.0	9.9	.0047	+	.47	+	.0021	NS	.17	NS	.0009	NS	.13	NS	.0026	+	.26	NS
Dry Park often rocky and calcareous - mainly grasses and forbs present	1.6	3.8	.0031	N	.25	NS	.0029	NS	.33	+	.0036	++	.46	++	.0032	NS	.35	+
Dry Park - grasses, forbs and shrubs present	1.8	5.8	.0002	NS	.05	-	.0009	NS	.06	NS	.0011	NS	.05	NS	.0007	NS	.05	--
Dry Park - grasses and forbs present	3.7	2.1	.0054	+	.55	++	.0005	NS	.07	-	.0006	NS	.08	-	.0022	NS	.24	NS
Dry Park - very rocky (rockslide)	0.2	1.0	0	NS	.50	NS	0	NS	0	NS	0	NS	0	NS	0	NS	.17	NS
Wet Park (all)	9.4	2.1	.0018	NS	.22	--	.0009	NS	.07	--	.0009	NS	.11	NS	.0012	NS	.14	-
Wet or mesic park	1.0	2.8	.0022	NS	.33	NS	.0005	NS	.06	NS	.0009	NS	.09	NS	.0012	NS	.17	NS
Wet sedge park with AF/caca interspersed and/or immediately bordering	8.4	2.1	.0017	NS	.21	--	.0010	NS	.07	--	.001	NS	.11	NS	.0012	-	.13	--
All Park Types	24.7	4.6	.0032	NS	.34	NS	.0013	NS	.11	-	.0010	NS	.13	NS	.0019	NS	.20	NS
Dry Broken Park (all)	10.1	2.4	.0019	NS	.24	-	.0009	NS	.18	NS	.0011	NS	.13	NS	.0013	NS	.18	-
Dry Broken Park often rocky and calcareous - mainly grasses and forbs present	1.8	4.4	0	NS	0	--	.0008	NS	.21	NS	.0014	NS	.09	NS	.0007	NS	.09	-
Dry Broken Park - grasses, forbs, and shrubs present	1.1	3.6	0	NS	0	NS	.001	NS	.27	NS	0	NS	0	-	.0003	NS	.09	-
Dry Broken Park - grasses and forbs present	7.2	1.8	.0026	NS	.32	NS	.0009	NS	.16	NS	.0012	NS	.16	NS	.0016	NS	.22	NS
Wet Broken Park (all)	11.4	1.4	.0023	NS	.27	-	.0017	NS	.13	NS	.0016	NS	.16	NS	.0019	NS	.19	NS
Wet or mesic broken park	1.4	3.7	.0005	NS	.30	NS	.0004	NS	.07	NS	0	NS	0	-	.0003	NS	.13	NS
Wet sedge broken park with AF/caca interspersed and/or immediately bordering	10.0	1.2	.0025	NS	.27	-	.0018	NS	.13	NS	.0018	+	.18	NS	.0020	NS	.20	NS
All Broken Park Types	21.5	1.8	.0021	NS	.26	--	.0013	NS	.15	NS	.0014	NS	.15	NS	.0016	NS	.19	-

Table 5. Continued.

General Cover or Habitat Types Significance Level: P=.05 / P=.01 Above overall average: + / ++ Below overall average: - / -- NS = nonsignificant (AF = *Abies lasiocarpa*)	Percent availability in Route System	Average size (area in acres)	1972				1973				1974				1972-1974			
			Elk Use and Z Value				Elk Use and Z Value				Elk Use and Z Value				Elk Use & Z Value			
			$\bar{X}$ = .0029		$\bar{X}$ = .3407		$\bar{X}$ = .0014		$\bar{X}$ = .1641		$\bar{X}$ = .0012		$\bar{X}$ = .1521		$\bar{X}$ = .0019		$\bar{X}$ = .2214	
			PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z	PG	Z	GIEU	Z
AF/*Vaccinium scoparium - Vaccinium scoparium* phase	12.8	N/A	.0046	+	.52	++	.0020	NS	.28	+	.0008	NS	.18	NS	.0025	+	.33	++
AF/*Vaccinium scoparium - Thalictrum occidentale* phase	6.1	N/A	.0015	NS	.20	-	.0026	NS	.16	NS	.0006	NS	.11	NS	.0014	NS	.15	-
AF/*Vaccinium scoparium - Thalictrum occidentale* phase with AF/caca interspersed	1.6	N/A	.0061	+	.50	NS	.0007	NS	.21	NS	.0020	NS	.21	NS	.0031	NS	.31	NS
AF *(Pinus albicaulis)/Vaccinium scoparium*	19.6	N/A	.0036	NS	.44	++	.0015	NS	.18	NS	.0010	NS	.12	NS	.0021	NS	.25	NS
AF/*Vaccinium scoparium-Calamagrostis rubescens* phase	0.5	N/A	0	NS	0	NS	.005	NS	1.0	NS	.002	NS	.50	NS	.0023	NS	.50	NS
AF/*Calamagrostis rubescens*	1.1	N/A	.0017	NS	.50	NS	0	NS	0	NS	0	NS	0	NS	.0006	NS	.17	NS
AF/*Luzula hitchcockii - Vaccinium scoparium* phase	1.5	N/A	.0031	NS	.78	++	0	NS	.11	NS	.0023	NS	.50	++	.0022	NS	.53	++
AF/*Menziesia ferruginea*	0.2	N/A	.0021	NS	.50	NS	0	NS	0	NS	0	NS	0	NS	.0007	NS	.17	NS
AF/*Calamagrostis canadensis* (often only a stringer)	1.8	N/A	.0015	NS	.11	-	.0012	NS	.15	NS	.0014	NS	.08	NS	.0014	NS	.11	-
AF/*Xerophyllum tenax - Vaccinium scoparium* phase	0.5	N/A	.0010	NS	.50	NS	0	NS	.50	NS	0	NS	.50	NS	.0003	NS	.50	NS
Pinus albicaulis	4.6	N/A	.0007	NS	.25	NS	.0004	NS	.14	NS	.0001	NS	.05	-	.0004	-	.15	-
Pseudotsuga menziesii/Juniperus communis	0.6	N/A	.0043	NS	.75	NS	.0043	NS	.50	+	0	NS	0	NS	.0029	NS	.42	NS
Pseudotsuga menziesii/Calamagrostis rubescens	0.4	N/A	0	NS	0	NS	.0013	NS	.17	NS	.0044	+	.33	NS	.0019	NS	.17	NS
Timber (all)	51.3	N/A	.0032	NS	.40	+	.0016	NS	.20	+	.0010	NS	.14	NS	.0019	NS	.25	NS
Clearcut - cut through timber	1.6	100	0	NS	.14	NS	.0018	NS	.36	+	.0018	NS	.64	++	.0012	NS	.38	NS
Dry Park-cut through within a clearcut	0.4	2.5	0	NS	0	NS	.0057	NS	0.5	+	.0182	++	1.0	++	.0080	++	.50	+
Wet or mesic park - cut through within a clearcut	0.5	2.8	0	NS	0	NS	0	NS	0	NS	.0068	++	.75	++	.0023	NS	.25	NS
Clearcut (all)	2.5	N/A	0	NS	.08	-	.0019	NS	.27	NS	.0059	++	.73	++	.0026	NS	.36	++

Z = significance of standard normal deviate.
$\bar{X}$ = overall average of elk use for respective year and elk use measurement method.
PG = pellet groups/pace/segment.
GIEU = general impression elk use.

Table 6. General cover and habitat types and elk use relationships on the route system in the Long Tom Cr. study area for the fall season (September-November).

General Cover or Habitat Type Significance Level: P= .05 / P=.01 Above overall average: + / ++ Below overall average: - / -- NS = nonsignificant	Percent availability in Route System	Average size (area in acres)	1971 Elk Use & Z Value		1972 Elk Use & Z Value		1973 Elk Use & Z Value		1971-1973 Elk Use & Z Value	
			$\bar{X}$ = .0199		$\bar{X}$ = .0184		$\bar{X}$ = .0078		$\bar{X}$ = .0154	
			PG	Z	PG	Z	PG	Z	PG	Z
Dry Park (all)	15.3	6.1	.0293	++	.0302	NS	.0087	NS	.0227	++
Dry Park with *Festuca idahoensis* and/or *Agropyron spicatum* dominant	8.0	9.9	.0021	NS	.0146	NS	.0085	NS	.0149	NS
Dry Park often rocky and calcareous - mainly grasses and forbs present	1.6	3.8	.0189	NS	.0064	NS	.0083	NS	.0112	NS
Dry Park - grasses, forbs, and shrubs present	1.8	5.8	.0661	++	.0166	NS	.0167	+	.0331	++
Dry Park - grasses and forbs present	3.7	2.1	.0327	+	.0624	++	.0072	NS	.0341	++
Dry Park - very rocky (rockslide)	0.2	1.0	0	NS	0	NS	0	NS	0	NS
Wet Park (all)	9.4	2.1	.0235	NS	.0192	NS	.0050	NS	.0160	NS
Wet or mesic park	1.0	2.8	.0095	NS	.0080	NS	.0175	+	.0116	NS
Wet sedge park with AF/caca interspersed and/or immediately bordering	8.4	2.1	.0253	NS	.0207	NS	.0034	-	.0164	NS
All Park Types	24.7	4.6	.0269	++	.0256	++	.0072	NS	.0199	++
Dry Broken Park (all)	10.1	2.4	.0127	-	.0090	-	.0053	NS	.0090	--
Dry Broken Park often rocky and calcareous - mainly grasses and forbs present	1.8	4.4	.0057	NS	.0004	NS	0	NS	.0020	-
Dry Broken Park - grasses, forbs, and shrubs present	1.1	3.6	.0204	NS	.0084	NS	.0017	NS	.0101	NS
Dry Broken Park - grasses and forbs present	7.2	1.8	.0134	NS	.0107	NS	.0061	NS	.0101	-
Wet Broken Park (all)	11.4	1.4	.0117	-	.0174	NS	.0036	--	.0109	--
Wet or mesic broken park	1.4	3.7	.0108	NS	.0077	NS	.0021	NS	.0069	NS
Wet sedge broken park with AF/caca interspersed and/or immediately bordering	10.0	1.2	.0117	-	.0183	NS	.0037	-	.0113	--
All Broken Park Types	21.5	1.8	.0121	--	.0139	NS	.0043	--	.0101	--

Table 6. Continued.

General Cover or Habitat Type Significance Level: P=.05 / P=.01 Above overall average: + / ++ Below overall average: - / -- NS = nonsignificant (AF = *Abies lasiocarpa*)	Percent availability in Route System	Average size (area in acres)	1971		1972		1973		1971--1973	
			Elk Use & Z Value		Elk Use & Z Value		Elk Use & Z Value		Elk Use & Z Value	
			$\bar{X}$ = .0199		$\bar{X}$ = .0184		$\bar{X}$ = .0078		$\bar{X}$ = .0154	
			PG	Z	PG	Z	PG	Z	PG	Z
AF/*Vaccinium scoparium-Vaccinium scoparium* phase	12.8	N/A	.0246	NS	.0178	NS	.0115	+	.0180	NS
AF/*Vaccinium scoparium-Thalictrum occidentale* phase	6.1	N/A	.0251	NS	.0105	NS	.0080	NS	.0145	NS
AF/*Vaccinium scoparium-Thalictrum occidentale* phase with AF/caca interspersed	1.6	N/A	.0198	NS	.0169	NS	.0067	NS	.0111	NS
AF/(*Pinus albicaulis*)/*Vaccinium scoparium*	19.6	N/A	.0194	NS	.0211	NS	.0128	++	.0178	NS
AF/*Vaccinium scoparium* - *Calamagrostis rubescens* phase	0.5	N/A	.0060	NS	.0140	NS	.0020	NS	.0073	NS
AF/*Calamagrostis rubescens*	1.1	N/A	.0122	NS	.0256	NS	.0052	NS	.0143	NS
AF/*Luzula hitchcockii* - *Vaccinium scoparium* phase	1.5	N/A	.0209	NS	.0190	NS	.0063	NS	.0154	NS
AF/*Menziesia ferruginea*	0.2	N/A	.0083	NS	.0661	NS	.0083	NS	.0276	NS
AF/*Calamagrostis canadensis* (often only a stringer)	1.8	N/A	.0088	NS	.0236	NS	0	NS	.0128	NS
AF/*Xerophyllum tenax* - *Vaccinium scoparium* phase	0.5	N/A	0	NS	0	NS	0	NS	0	NS
Pinus albicaulis	4.6	N/A	.0136	NS	.0086	NS	.0058	NS	.0093	NS
Pseudotsuga menziesii/*Juniperus communis*	0.6	N/A	.0082	NS	.0222	NS	.0153	NS	.0152	NS
Pseudotsuga menziesii/*Calamagrostis rubescens*	0.4	N/A	.0274	NS	.0126	NS	.0071	NS	.0157	NS
Timber (all)	51.3	N/A	.0204	NS	.0175	NS	.0103	+	.0160	NS
Clearcut - cut through timber	1.6	100	.0103	NS	.0011	NS	.0034	NS	.0050	NS
Dry Park - cut through within a clearcut	0.4	2.5	.0505	NS	0	NS	.0136	NS	.0214	NS
Wet or mesic park - cut through within a clearcut	0.5	2.8	.0169	NS	.0017	NS	.0066	NS	.0084	NS
Clearcut (all)	2.5	N/A	.0185	NS	.0015	NS	.0060	NS	.0086	NS

Refer to Table 5 for footnotes.

than those classified as dry (Fig. 10). That portion of the route system categorized as wet comprised 32 and 37 percent of the total route system in 1973 and 1974, respectively. The percent of the total elk use that occurred in these wet portions was 48 and 43 percent, respectively, for the pellet group method, and 53 and 54 percent, respectively, for the GIEU method.

During September and early October for 1972-1974 wetness degree did not appear to be as important a characteristic of elk use areas as during the summer months (Fig. 11). Wallow sites contributed significantly to those wet segments that received high elk use during this season. Elk use of the dry segments was nearly proportionate to their occurrence in all cases. Seventy, 75, and 76 percent of the route system was dry for 1972, 1973, and 1974, respectively. That portion of the total elk use measured by the pellet group method was 70, 83, and 70 percent, respectively for these years, and 72, 81, and 70 percent for the GIEU method.

Topography

During the summer season for all 3 years, those segments of the route system classified as bench or swale received elk use that was significantly above the average elk use of all segments. Elk use in those segments classified as lower slope and creek bottom was, in general, significantly ($P = .05$) below this average (Fig. 12). The other topographic classifications (ridge, upper slope, and mid-slope) were used in proportion to their availability in 1972 and 1973, while in 1974 upper slope received significantly more elk use than the others for both elk use measurement methods.

As during the summer season for all 3 years, elk appeared to significantly avoid those segments classified as lower slope and creek bottom during the rut. A shift of elk use from the bench-or swale category to the mid-slope category during the rut was very apparent for all 3 years and both elk use methods, except in 1973 for the pellet group method (Fig. 13). Ten of the 12 elk use relationships with the ridge and upper slope categories did not deviate significantly above or below the average.

Sight Distance

An attempt was made to evaluate elk use-timber density relationships. Estimated sight distance within each segment was used as an index of timber density.

During June-August for all years and both elk use methods there was much variation of elk use within and between each sight distance category (Fig. 14). Although this variation existed there was a trend of elk use

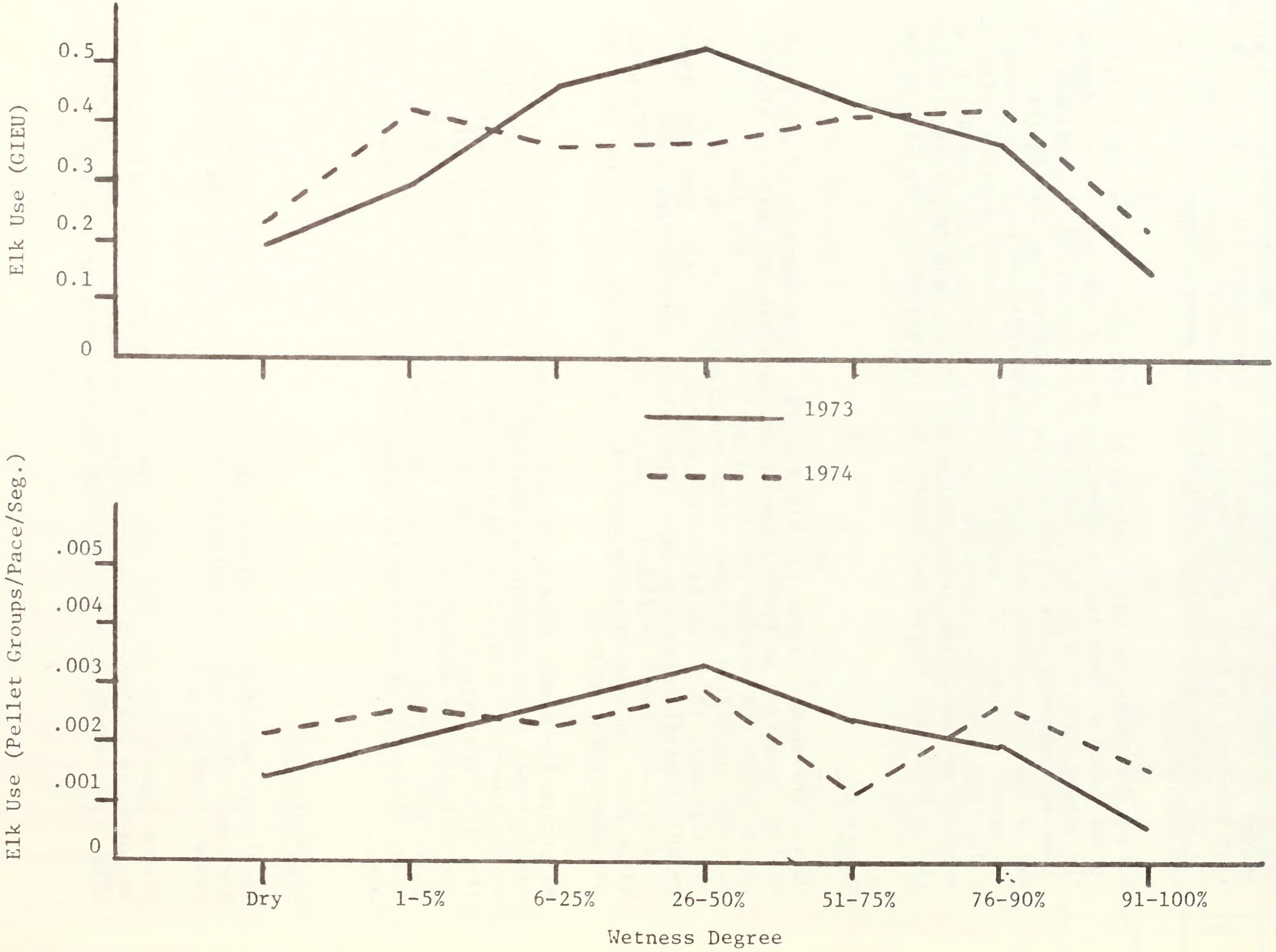


Figure 10. Elk use related to Wetness Degree Categories classified in Route System for June-August 1973-74.

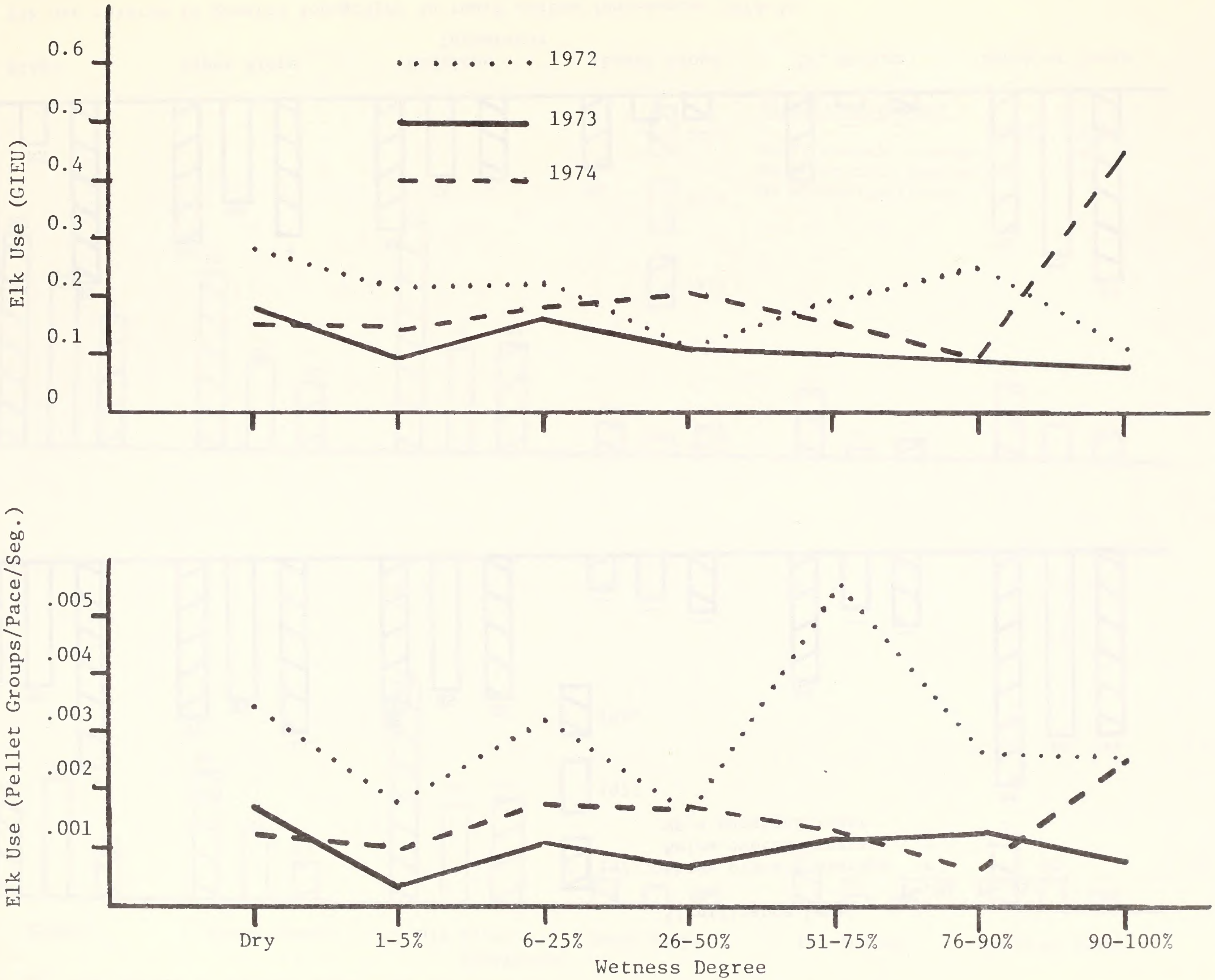


Figure 11. Elk use related to Wetness Degree Categories Classified in Route System September-early October 1972-74.

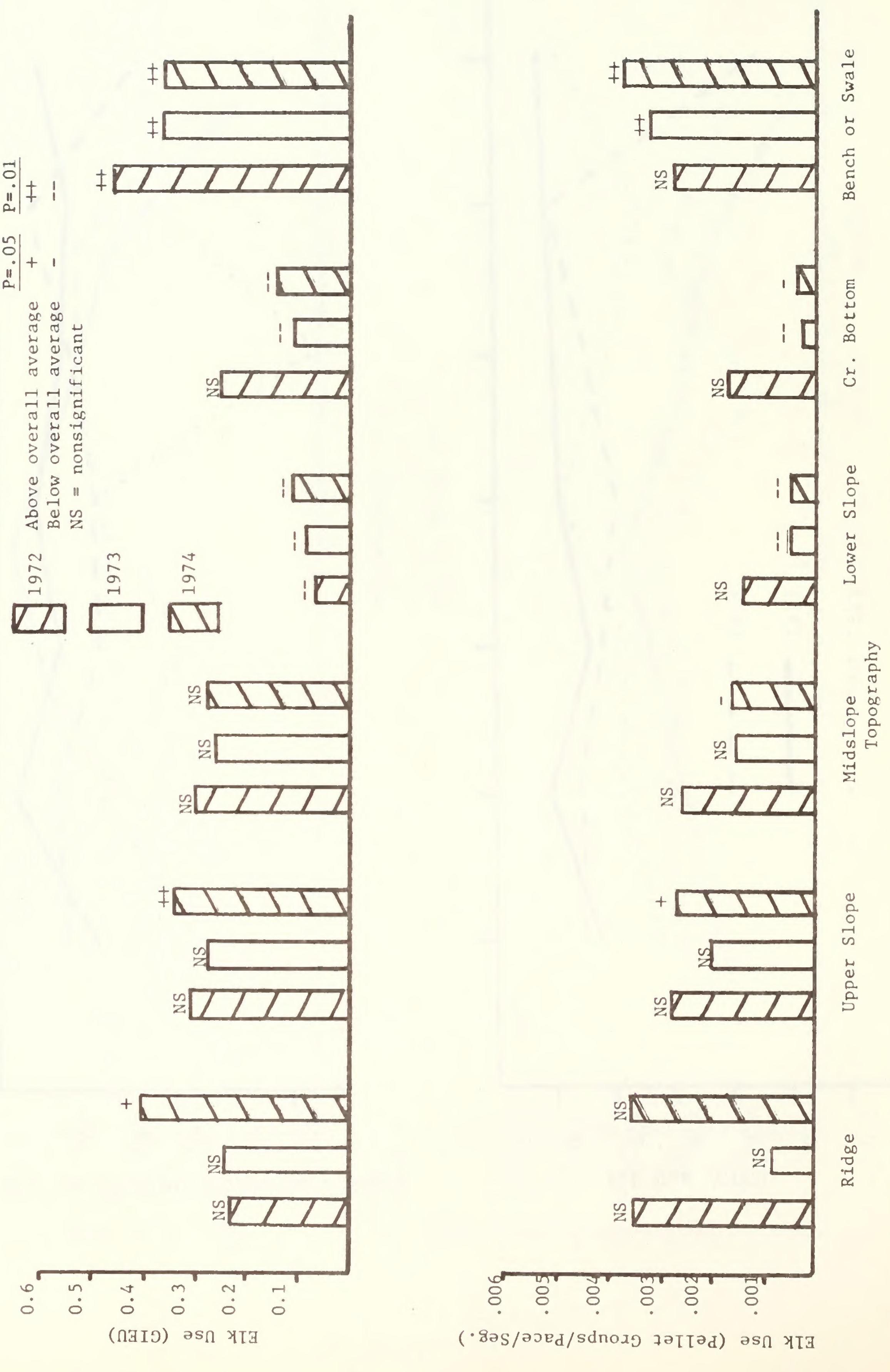


Figure 12. Elk use related to general topography in route system June-August 1972-74.

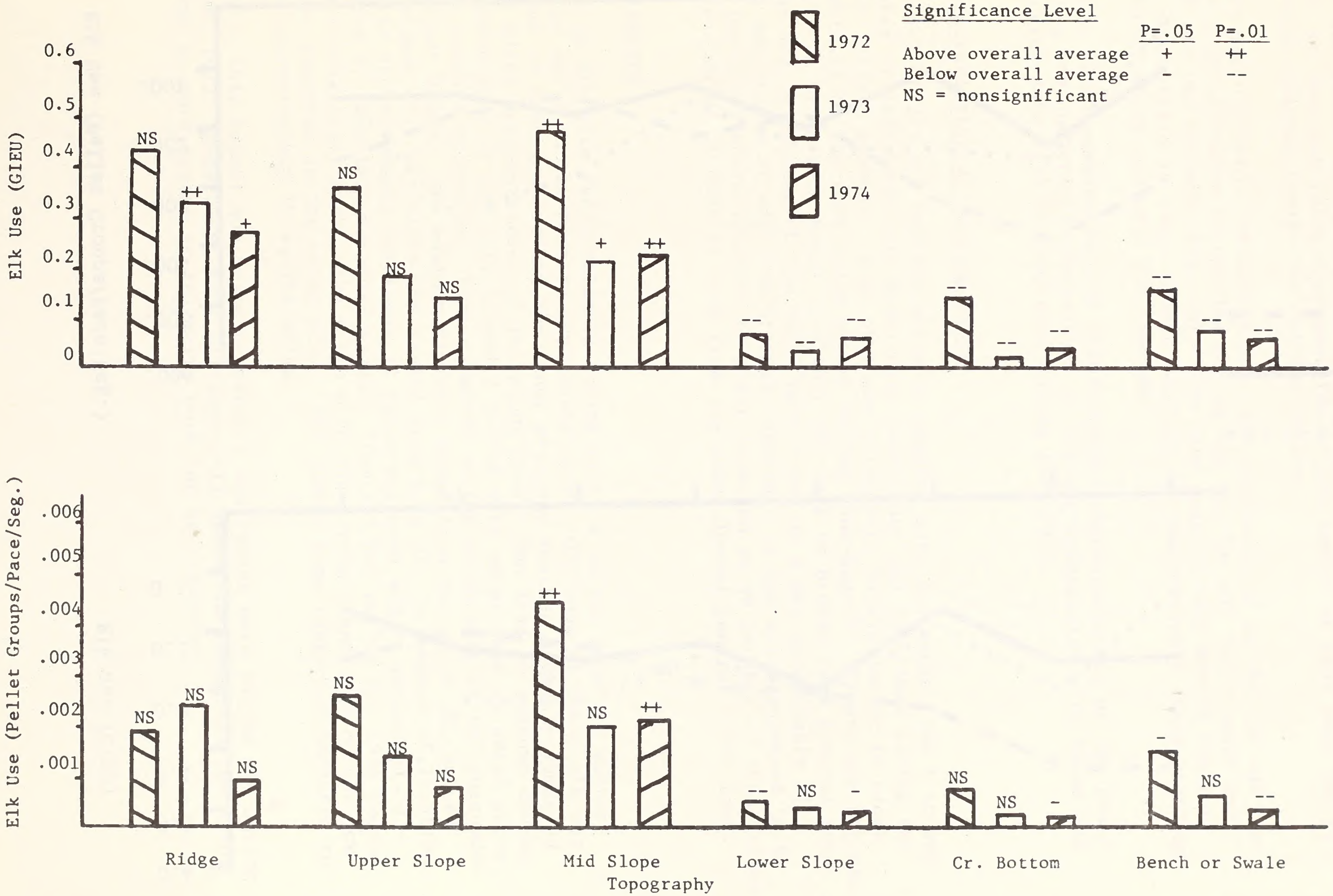


Figure 13. Elk use related to general topography in route system September-early October 1972-74.

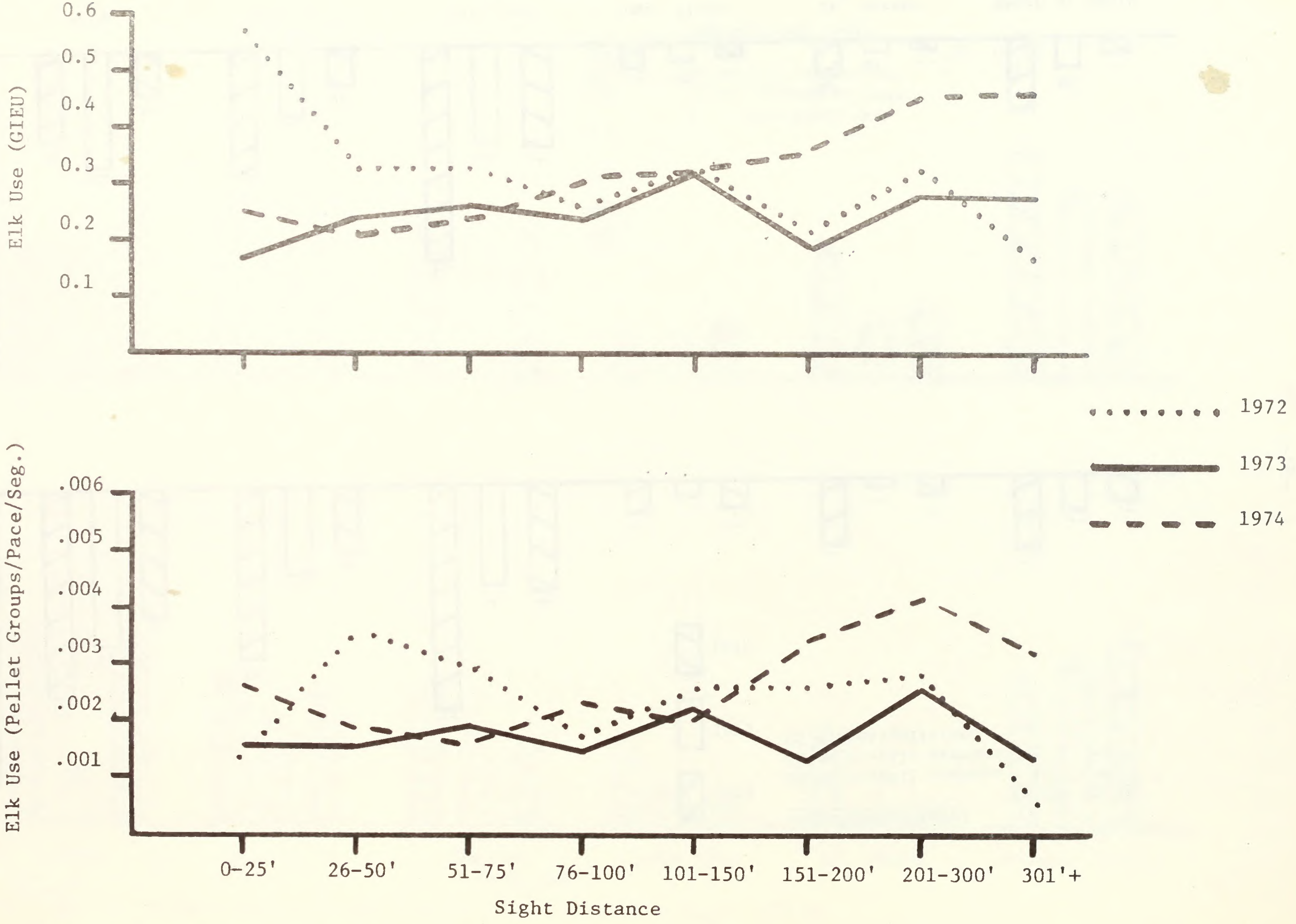


Figure 14. Elk use related to sight distance categories in route system June-August 1972-74.

progressively increasing from the least to the most sight distance in 1973 and 1974. Since the summer data from 1972 was gathered in August only, it does not fully represent the entire summer of that year and is probably slanted toward the rutting season.

There was a general indication that elk concentrated in the low and the high sight distance categories during the rut for all three years and both elk use methods (Fig. 15). The data suggest that during the rut elk concentrate in dense timber adjacent to comparatively large openings (parks), which are used for feeding.

Future field measurements of physiographic characteristics of the route system and analytical comparisons of elk use intensities with these and existing data will be completed during 1975-1976.

Characteristics of Bedding Sites

A total of 213 elk bedding sites (a bedding site may range from 1 to any number of individual elk beds) have been found and described during the past 3 field seasons. Most of these sites were located on or in close proximity to the foot route system during June-August. Ninety-one percent of these sites were found in either the park or broken park general cover type and 78 percent of the total were found on a wet site (Table 7). The importance of edge and/or small openings to bed sites appeared to be an important characteristic of their location as 68 percent of these sites were located 50 feet or less from the next closest general cover type.

Telemetry

Eleven elk were radio-collared during April 4 on the High Rye winter range and 7 on the Fleecer Game Range area. Only one of these elk was known to have summered in the study area and another probably summered 2-5 miles east-northeast of the study area. Two died by unknown causes between June 14 and July 1, and 2 radios were never seen or heard after the capture operation. Four summered on the south side of the Anaconda-Pintlar Range. The maximum distance moved from the point of capture averaged 13.4 air miles and ranged from 6 to 27. A summary of location dates and movements for these 11 radio-equipped elk is presented in Table 8. The last recorded signals from all but one of the 1974 radios were moderately weak. The radio with the strong signal was on the cow that summered in the study area. Its summer home range was measured to be approximately 1½ square miles.

While this report was being prepared 7 new radios were put on elk during May, 1975. Hopefully, most of these will spend the summer in the study area so more intensive telemetry work can be conducted.

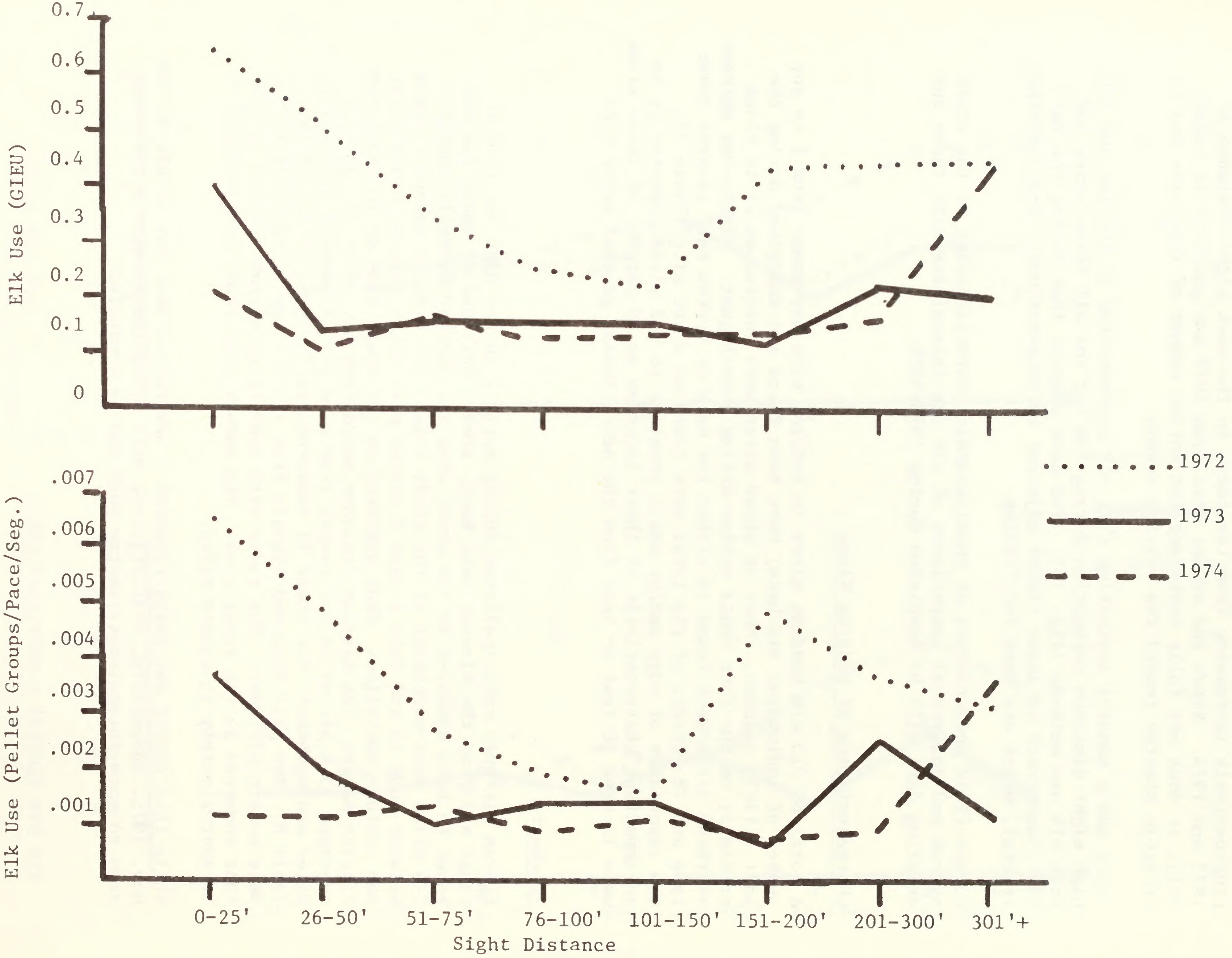


Figure 15. Elk use related to sight distance categories in route system September-Early October 1972-74.

Table 7. Percentage of 213 elk bedding sites as related to various physical characteristics measured in the Long Tom Creek Study Area during Summer and Fall, 1972-1974.

General[1] Cover Type				Dominant[2] Ground Cover		Wetness Type[3]				Wetness Degree	
P	BP	T	CC	Car. spp., SETR, LEGL, PHAL	OTHER	RW, M	M, B,	ALL WET	DRY	0-50%	50-100%
43	48	6	3	83	17	24	54	78	22	47	53

DOWNFALL[4]				SIGHT DISTANCE			DISTANCE TO NEXT CLOSEST GENERAL COVER TYPE					
N	L	M	H	0-75'	75'-200'	200'+	0-10'	11'-25'	26'-50'	51'-100'	100'-200'	200'+
69	30	1	0	42	53	5	8	25	35	21	8	3

[1] P = park, BP = broken park, T = timber, CC = clearcut.

[2] Car = Carexes; Setr = *Senecio triangularis;* LEGL = *Ledum glandulosum;* PHAL = *Phleum alpinum L.*

[3] RW = running water, M = marsh, B = bog, SW = standing water.

[4] N = none, L = light, M = moderate, H = heavy.

Table 8. Some general statistics on 11 cow elk that were radio-equipped and tracked during the spring, summer, and fall of 1974.

Radioed Elk Ch. No.	Sex	Age	Winter Range where collared	Dates of first-last location during 1974	General vicinity of summer range	Locations and Distances (Aerial Miles): Between Successive Relocations[1] April-May	June-Aug.	Sept.	Oct.	Totals[2]	Mean	Max. between any 2 locations	Min. between any 2 locations	Max. from where captured
1	F	Ad.	High-Rye	4/ 1-6/19 (elk dead)	Unknown	6/ .9	3/ .5	-	-	9/ 6	.66	1	0	1.5
2	F	Ad.	Fleecer	4/17-10/23	Hungry Hill (Study area)	6/ 1.2	6/ 1.4	1/ 2.5	2/ 2.5	15/ 23	1.4	5.5	0	10
3	F	Ad.	Fleecer	4/ 1-5/16	Unknown	5/ 1.7	-	-	-	5/ 1.7	3.4	6.5	3	16.5
4	F	Ad.	Fleecer	4/17-6/30	Anaconda-Pintlars	4/ 4.9	2/ 7	-	-	6/ 33.5	5.6	12.5	0.5	19
5	F	Ad.	Fleecer	4/16-8/12	Anaconda-Pintlars	4/ 7	5/ 4.5	-	-	9/ 32.5	3.6	20	0	21.5
6	F	Ad.	High-Rye	4/17	-	-	- /could not locate after capture/					-	-	-
7	F	Ad.	Fleecer	4/16-7/24	Anaconda-Pintlars	5/ 4.8	5/ 1.8	-	-	10/ 33	3.3	11.5	0.5	27
8	F	Ad.	High-Rye	4/17	-	-	-/could not locate after capture/					-	-	-
9	F	1½	Fleecer	4/16-7/24	Anaconda Pintlars	2/ 10.8	5/ 1.4	-	-	7/ 29	4.5	21	0.5	22
10	F	Ad.	High-Rye	4/17-7/24	Greenland Gulch Area	1/ 1	4/ 2.6	-	-	5/ 11.5	2.3	6	1	6
11	F	Ad.	Fleecer	4/16-7/3 (elk dead)	Fleecer Ridge	4/ .8	4/ .7	-	-	8/ 11	1.4	4.5	0	4

[1] Number of locations/average distance between each location.

[2] Total number of locations/total miles.

Time-lapse Photography

Three time-lapse cameras were used to measure elk use in a 30 acre park, and 10 and 5 acre broken parks. These areas are all part of the foot route system so elk use was monitered by both camera and ground survey.

The camera in the park was employed July through most of September while the other 2 units were employed July through October. A total of 6,492 frames were exposed in the park; 874 (13%) had cattle in them and none had elk. A total of 11,602 frames were exposed in the 10 acre broken park; 461 (4%) had cattle and 1 included a cow elk. A total of 8,742 frames were exposed in the 5 acre broken park; 180 (2%) had cattle and 2 had elk (1 elk in each frame). This totaled to 26,836 frames of which 1,515 (5.5%) had cattle and only 3 had elk. The elk use that occurred was not concurrent with the cattle use. In the 5 acre broken park the elk use documented by both camera and ground survey occurred before the cattle moved in. The elk use in the 10 acre broken park occurred in October after the cattle were out of this area and was recorded only by the camera. No elk use of the large park was recorded by the route survey that corresponded to the time the camera was employed in this area.

Although these data are limited to 3 small areas within the study area, it does provide a very systematic and intensive measurement of elk use in each area during the daylight hours. The use of cameras in a variety of clearcuts would provide valuable information on elk use. It would also be useful to use cameras in natural openings that will be cut through or immediately adjacent to proposed clearcuts before, during, and after the logging operation. Two of the three natural openings mentioned above meet these criteria.

Elk - Cattle Distribution and Interspecific Relationships

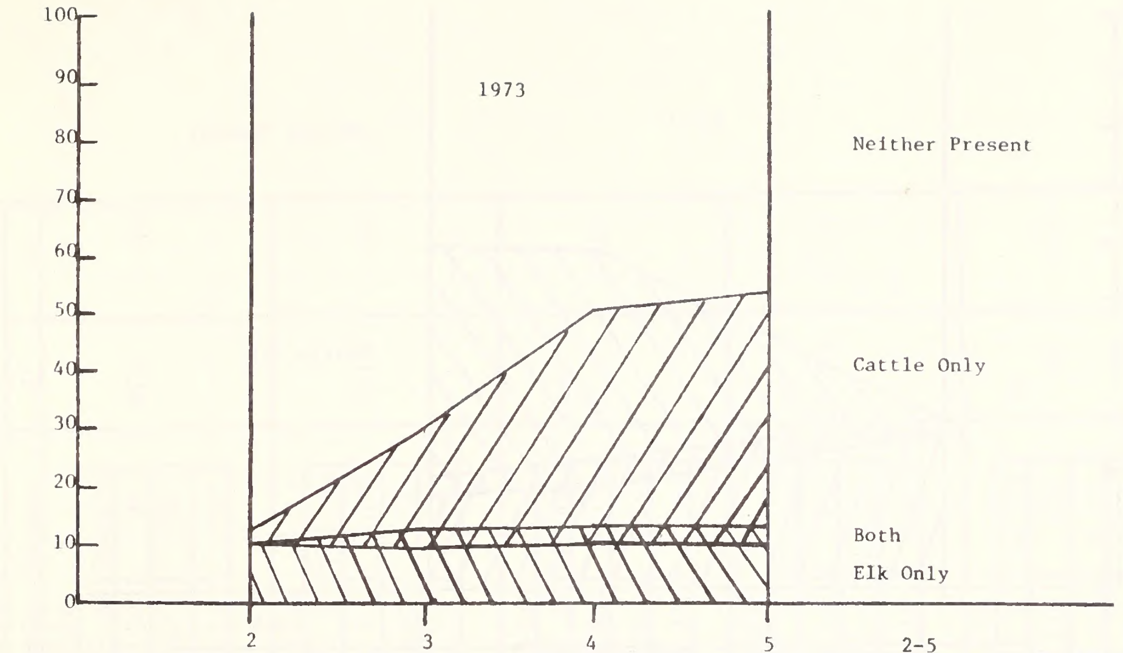
Interspecific association measurements between elk and cattle showed a significant negative response of elk towards cattle during the summers of 1973 and 1974. Cattle use of the area (reflected by both dropping counts and ocular estimation of forage use) has generally occurred between early July and mid-October. Data were not used for run 1, since cattle were not in the study area that early in the summer.

Figures 16 and 17 illustrate the proportions of the route system used by cattle only, elk only, both, or neither for run 2 through run 5 (Approximately July 1 - September 20) and for runs 2-5 combined for both years. As cattle use of the route system became more extensive with the progression of the summer, elk use either remained the same or became less extensive; that portion of the route system with both cattle and elk sign present simultaneously did not occur more than 5 percent of the time for any particular run.

Coefficient of association values (Cox, 1970) were calculated based on data collected during runs 2 through 5 for both years. This coefficient could vary from +1.0 indicating a condition of maximum possible co-occurrence to -1.0 indicating a condition of minimum possible co-occurrence. Positive associations, or co-occurrence more frequently than expected by chance, may indicate existence of co-actions desirable to one or both species. Negative associations, or co-occurrence less frequently than expected by chance, may be indicative of co-actions undesirable to one or both species. A value of 0 indicates the frequency of co-occurrence expected by chance.

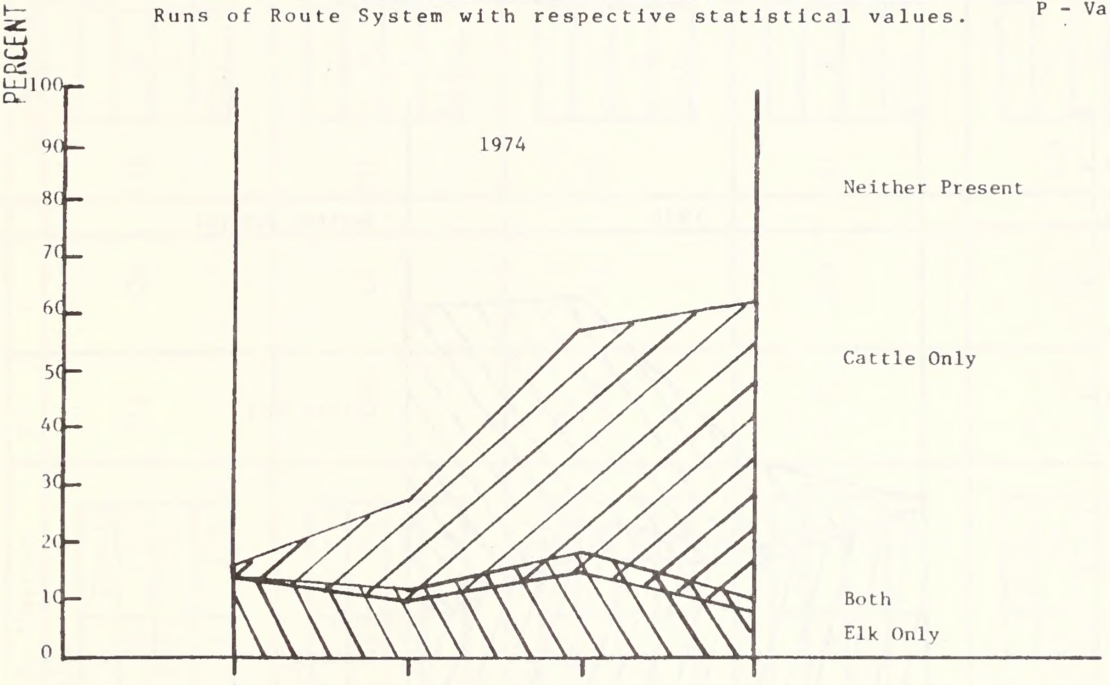
For 17 out of 20 runs (or combinations of runs) these coefficients were significantly negative. The other 3 values were very close to 0 (.02, -.04, .07) and occurred early in the summer (runs 2 and 3) as cattle were just moving into the study area. For both years and for both elk use measurement methods these negative values tended to progressively increase in magnitude as the season advanced. The average coefficient of association value for runs 2 through 5 in 1973 was -.29 for the pellet group elk use method and -.55 for the General Impression Elk Use (GIEU) method; for 1974 these figures were -.54 and -.71, respectively.

A 2x2 Chi square test was used to determine the significance level of the deviations between observed values and those expected on the basis of chance association between the cattle and elk. Calculation of the chi-square value for any run(s) was not made when the expected value for any cell of the contingency table was less than 5. Contingency tables with observed data, proportions tested, and chi-square values are presented in Tables 9 and 10. Sixteen proportions were tested; both elk use measurement methods were used for each of runs 3 through 5 and 3-5 combined. The null hypothesis tested was: that the proportions of segments used by elk were the same for segments with and without cattle use.



2	3	4	5	2-5	
.02	.07	-.45	-.50	-.29	Coefficient of Association
N/A	.21	.0003**	.0001**	.02*	Chi-square P - Value

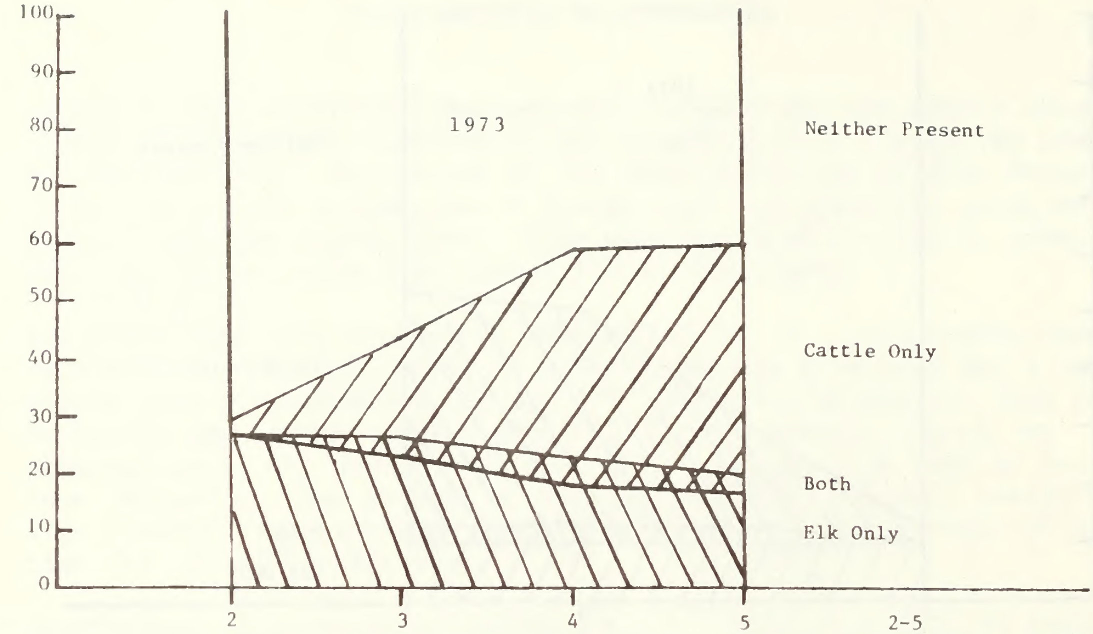
Runs of Route System with respective statistical values.



2	3	4	5	2-5	
-.04	-.27	-.54	-.66	-.55	Coefficient of Association
N/A	.29	.0000**	.0000**	.004**	Chi-square P - Value

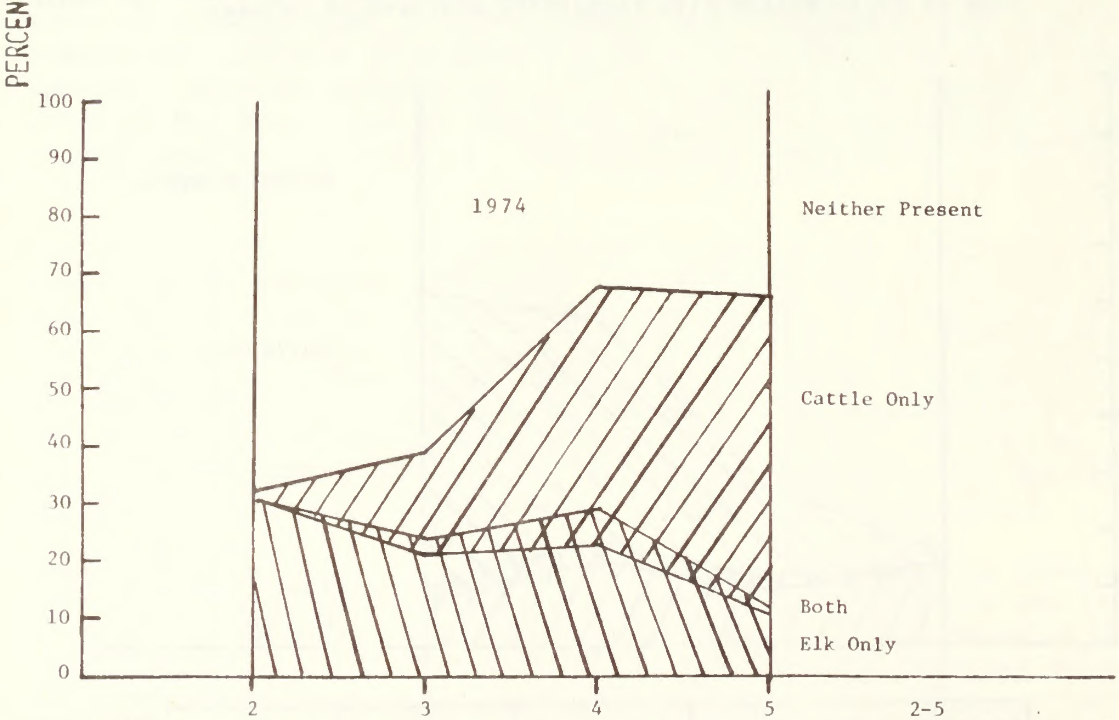
Runs of Route System with respective statistical values.
*Significantly Different P ≤ .05. **Highly Significantly Different P ≤ .01.

Figure 16. Proportion of route system used by elk and/or cattle for the summers of 1973 and 1974 based on the pellet group elk use method.



	2	3	4	5	2-5
Coefficient of Association	-.27	-.44	-.47	-.61	-.54
Chi-square P - Value	N/A	.0008**	.0000**	.0000**	.003**

Runs of Route System with respective statistical values.



	2	3	4	5	2-5
Coefficient of Association	-.76	-.58	-.65	-.73	-.71
Chi-square P - Value	N/A	.0003**	.0000**	.0000**	.0008**

Runs of Route System with respective statistical values.
*Significantly Different P ≤ .05. **Highly Significantly Different P ≤ .01.

Figure 17. Proportion of route system used by elk and/or cattle for the summers of 1973 and 1974 based on the general impression of elk use method.

Table 9. Intra-run segment observations of elk and/or cattle use based on the pellet group elk use method for the summers of 1973 and 1974.

Run No.	1973							1974						
	Contingency Table Values					X²	C	Contingency Table Values					X²	C
			Cattle							Cattle				
			P	A	Totals					P	A	Totals		
2	Elk	P	2	78	80	N/A	.02	Elk	P	1	97	98	N/A	-.04
		A	13	607	620				A	12	590	602		
		%Elk	13	11	700				%Elk	8	14	700		
3	Elk	P	25	69	94	1.56	.07	Elk	P	11	73	84	1.13	-.27
		A	123	483	606				A	114	502	616		
		%Elk	17	13	700				%Elk	9	13	700		
4	Elk	P	22	76	98	** 14.66	-.45	Elk	P	26	105	131	** 35.31	-.54
		A	262	340	602				A	278	291	569		
		%Elk	7	18	700				%Elk	9	27	700		
5	Elk	P	20	70	90	** 19.12	-.50	Elk	P	13	56	69	** 39.85	-.66
		A	289	321	610				A	375	256	631		
		%Elk	6	18	700				%Elk	3	18	700		
2-5	Elk	P	69	293	362	** 5.46	-.29	Elk	P	51	331	382	** 7.68	-.55
		A	687	1751	2438				A	779	1639	2418		
		%Elk	9	16	2800				%Elk	6	18	2800		

P=Present; A=Absent; X^2=Chi-Square; C=Coefficient of Association.
*Significant Difference $P \leq .05$; **Highly significant difference $P \leq .01$.

Table 10. Intra-run segment observations of elk and/or cattle use based on the general impression of elk use method for the summers of 1973 and 1974.

Run No.	1973							1974						
	Contingency Table					X^2	C	Contingency Table					X^2	C
			Cattle							Cattle				
			P	A	Totals					P	A	Totals		
2	Elk	P	3	188	191	N/A	-.27	Elk	P	1	219	220	N/A	-.76
		A	12	497	509				A	12	468	480		
		%Elk	20	27	700				%Elk	8	32	700		
3	Elk	P	22	163	185	** 12.16	-.44	Elk	P	12	149	161	** 14.52	-.58
		A	126	389	515				A	113	426	539		
		%Elk	15	30	700				%Elk	10	26	700		
4	Elk	P	35	127	162	** 30.43	-.47	Elk	P	31	171	202	** 89.54	-.65
		A	249	289	538				A	273	225	498		
		%Elk	12	31	700				%Elk	10	43	700		
5	Elk	P	23	112	135	** 48.49	-.61	Elk	P	13	74	87	** 64.06	-.73
		A	286	279	565				A	375	238	613		
		%Elk	7	29	700				%Elk	3	24	700		
2-5	Elk	P	83	590	673	** 9.21	-.54	Elk	P	57	613	670	** 12.28	-.71
		A	673	1454	2127				A	773	1357	2130		
		%Elk	11	30	2800				%Elk	7	31	2800		

P=Present; A=Absent; X^2=Chi-Square; C=Coefficient of Association

*Significant Difference $P \leq .05$. ** Highly significant Difference $P \leq .01$.

In all but 3 tests a highly significant difference ($P \leq .01$) occurred between the proportion of elk use in those segments with cattle use (elk use lower) compared to the proportion of elk use in those segments without cattle use (elk use higher). The difference was significant at the $P = .02$ level for runs 3-5 combined, using the pellet group elk use method in 1973, and no significance was noted ($P \geq .05$) using this same elk use method for run 3 in both 1973 and 1974. The non-significance for run 3 was probably due to the overlapping, but not simultaneous, use by elk and cattle as cattle were just moving into the study area. The route system was walked every 3 weeks and both elk and cattle use would have been recorded even though the elk use may have occurred early in the 3 week period with the cattle use occurring later.

For the 14 chi-square tests that showed a significant difference between the two proportions, the null hypothesis as stated above would have to be rejected. This means that the difference between the two proportions did not occur by chance or by sampling error and that the difference could be largely attributed to a negative response of elk towards cattle in the study area.

By the fourth run of the route system, or by approximately the third week in August during both 1973 and 1974, cattle were well distributed throughout much of the study area (over 40% of the route system) and elk distribution had shifted to those portions of the study area where cattle use was light to none. This difference in distribution is reflected by the figures in Table 11. Although approximately 61 percent of the route system was used by elk and/or cattle, only 3 - 4 percent was used by both simultaneously.

Table 11. Percentages of route system used by elk or cattle[1].

	Percent of route system used	
	Elk pellet group Method	GIEU Method
Cattle only	43	42
Elk only	11	18
Both Elk and Cattle	3	4
Total	57	64

[1] Figures are averages for runs 4 and 5 for both years for both elk use methods.

Inter-run Comparisons

The negative associations cited from the previous data could have been the result of elk and cattle preferring different environmental conditions and consequently using different areas. Another analysis approach was used to help determine if a true negative association or response of elk toward cattle existed. For runs 1 through 4, each segment with elk use was compared to the type of use recorded in that segment the following run about 3 weeks later (runs 2 through 5) - use at that time was recorded as elk only, cattle only, elk and cattle together or neither. The analysis did not include run 1, since cattle were not in the study area that early in the summer. Both years and both types of elk use methods were used in this evaluation.

Sixteen coefficient of association values were calculated; all were negative, ranging from -.03 to -.73 (Tables 12 and 13). The average coefficient of association value for runs 3 through 5 in 1973 was -.44 for the pellet group elk use methods and -.53 for the GIEU method; for 1974 these values were -.39 and -.54, respectively.

As the cattle moved into the study area and became more evenly distributed, there became fewer places where elk could shift where cattle were not present or had not been. As the summer advanced, in spite of fewer places to go, the proportion of segments with elk use (when elk use was present the previous run) became progressively smaller while the proportion of segments with cattle use became progressively larger (Figs. 18 and 19). The proportion of segments with both elk and cattle use present did not exceed 11 percent for any of the runs, single or combined, and for both years averaged 5.4 and 5.7 percent for the pellet group elk use and the GIEU methods, respectively.

During both years for each of the two elk use recording methods the proportion of segments with cattle use tended to decline after run 4 (latter portion of August), indicating elk distribution had become relatively stabilized in those segments where cattle use did not occur and was most likely not to occur. This could have been partially influenced by the onset of the elk rutting season which appeared to cause a shift of elk use to relatively dense stands of timber where cattle seldom visited.

For each run, individual and combined, for both elk use methods during 1973 and 1974 the percentage of segments used by both elk and cattle was smaller than the percentage of segments used by elk only (Tables 12 and 13).

The percentage of segments used by both elk and cattle ranged from 8 to 26 (ave. 18) while the percentage of segments used by elk only ranged from 19 to 61 (ave. 41). The difference between these proportions for the individual and combined runs was statistically significant ($P \leq .05$) for 10 of the 16 sets of data and was highly significant ($P \leq .01$) for 8 of these 10.

Forage Use

Of total elk use recorded during the summer in those segments where forage use was measured (park, broken park, clearcut), over 80 percent (ave. 96%) occurred in that portion of the route system where forage use was measured to be 25 percent or less (Fig. 20). By run 5 (mid-September) while only

Table 12. Inter-run segment observations of elk and/or cattle use based on the pellet group elk use method for the summers of 1973 and 1974.

Run No.	1973						1974					
	Contingency Table				X^2	C	Contingency Table				X^2	C
	Elk	Cattle P	Cattle A	Totals			Elk	Cattle P	Cattle A	Totals		
1-2[1]	P	0	8	8	N/A	N/A	P	0	22	22	N/A	N/A
	A	1	35	36			A	1	41	42		
	%Elk	0	19	44			%Elk	0	35	64		
2-3	P	3	24	27	.58	-.11	P	5	25	30	.03	-.03
	A	11	42	53			A	14	54	68		
	%Elk	21	36	80			%Elk	26	33	98		
3-4	P	6	20	26	** 9.0	-.54	P	9	15	24	2.64	-.30
	A	41	27	68			A	36	24	60		
	%Elk	13	43	94			%Elk	20	38	84		
4-5	P	6	10	16	.14	-.16	P	6	21	27	* 4.48	-.47
	A	38	44	82			A	49	55	104		
	%Elk	14	19	98			%Elk	11	28	131		
2-5	P	15	54	69	2.39	-.44	P	20	83	103	2.26	-.39
	A	90	113	203			A	100	174	274		
	%Elk	14	33	272			%Elk	17	32	377		

P=Present; A=Absent X^2=Chi-Square; C=Coefficient of Association.
*Significant Difference $P \leq .05$. **Highly Significant Difference $P \leq .01$.

[1] Calculations not done, since cattle were not in the study area this early in the summer.

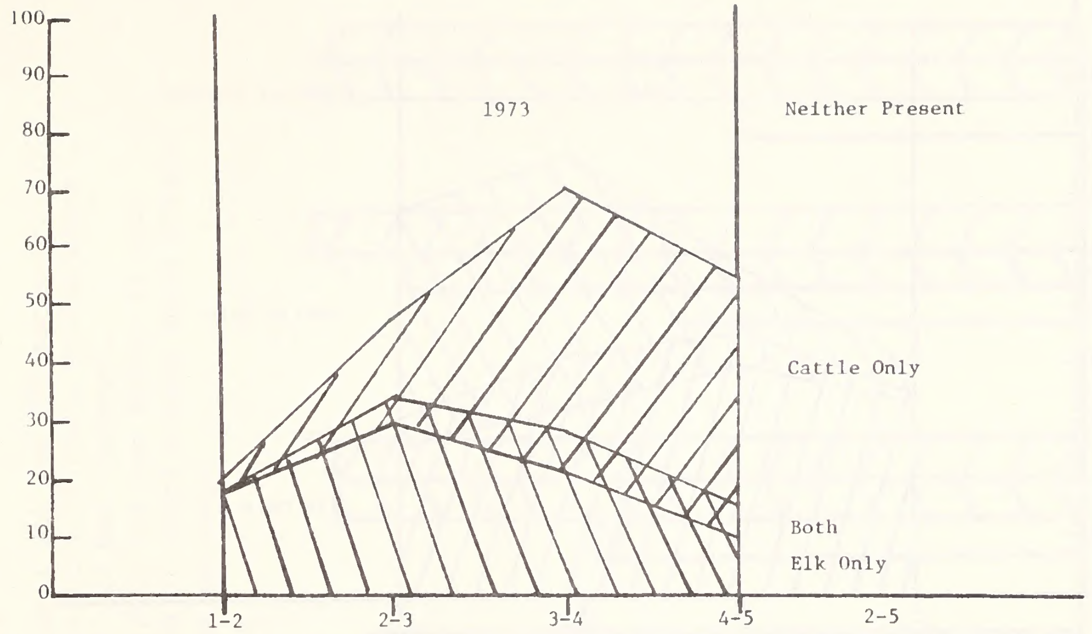
Table 13. Inter-run segment observations of elk and/or cattle use based on the general impression of elk use method for the summers of 1973 and 1974.

Run No.	1973						1974					
	Contingency Table				X^2	C	Contingency Table				X^2	C
	Elk	Cattle P	Cattle A	Totals			Elk	Cattle P	Cattle A	Totals		
1-2[1]	P	1	31	32	N/A	N/A	P	0	83	83	N/A	N/A
	A	4	57	61			A	3	94	97		
	%Elk	20	35	93			%Elk	0	47	180		
2-3	P	9	78	87	* 5.17	-.42	P	8	79	87	** 7.40	-.51
	A	25	79	104			A	33	100	133		
	%Elk	26	50	191			%Elk	20	44	220		
3-4	P	16	61	77	** 28.01	-.53	P	17	57	74	** 19.4	-.46
	A	66	42	108			A	51	36	87		
	%Elk	22	59	185			%Elk	25	61	161		
4-5	P	9	42	51	** 15.08	-.57	P	5	53	58	** 18.5	-.73
	A	57	54	111			A	59	85	144		
	%Elk	14	44	162			%Elk	8	38	202		
2-5	P	34	181	215	** 6.89	-.53	P	30	189	219	** 6.89	-.54
	A	148	175	323			A	143	221	364		
	%Elk	19	51	538			%Elk	17	46	583		

P=Present; A=Absent; X^2=Chi-Square; C=Coefficient of Association

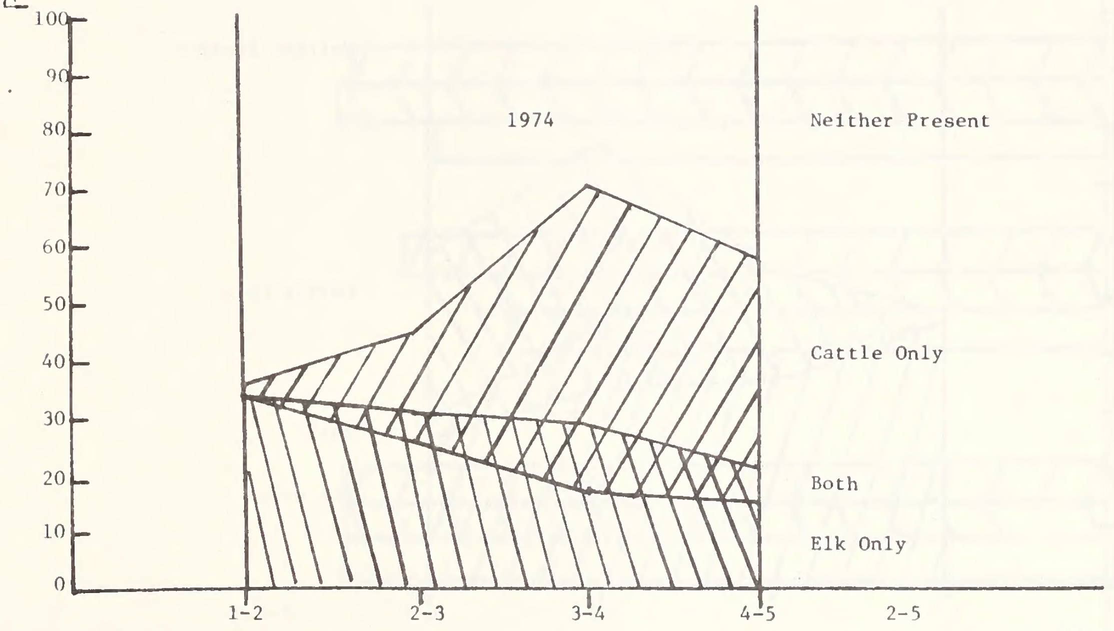
* Significant Difference $P \leq .05$. **Highly Significant Difference $P \leq .01$.

[1] Calculations not done, since cattle were not in the study area this early in the summer.



N/A	-.11	-.54	-.16	-.44	Coefficient of Association
N/A	.45	.003**	.71	.13	Chi-square P - Value

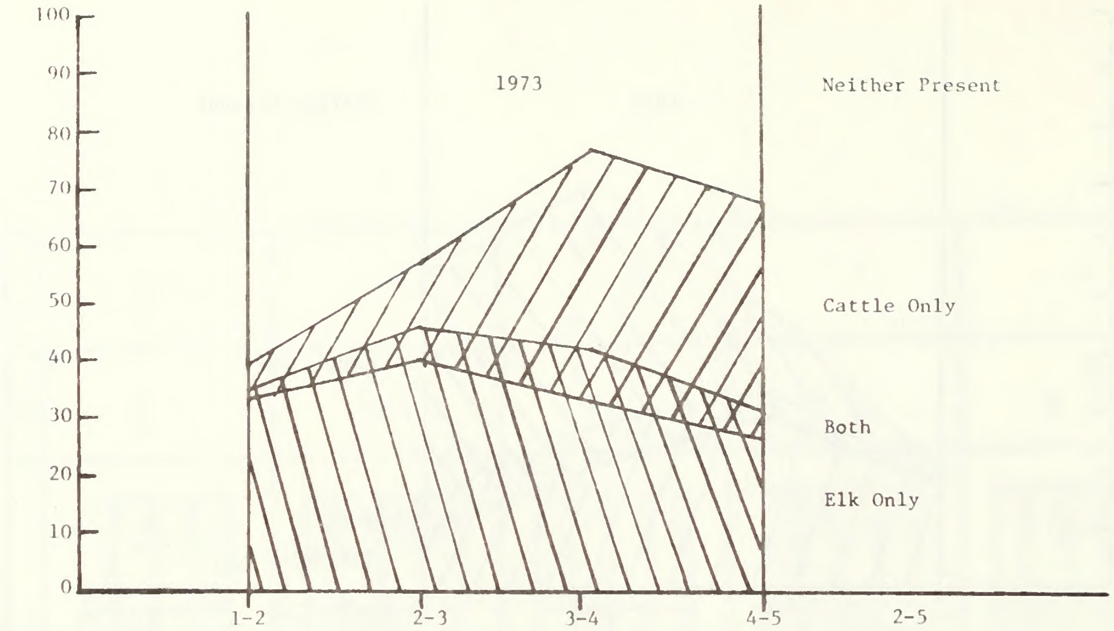
Runs of Route System with respective statistical values.



N/A	-.03	-.30	-.47	-.39	Coefficient of Association
N/A	.86	.10	.03*	.14	Chi-square

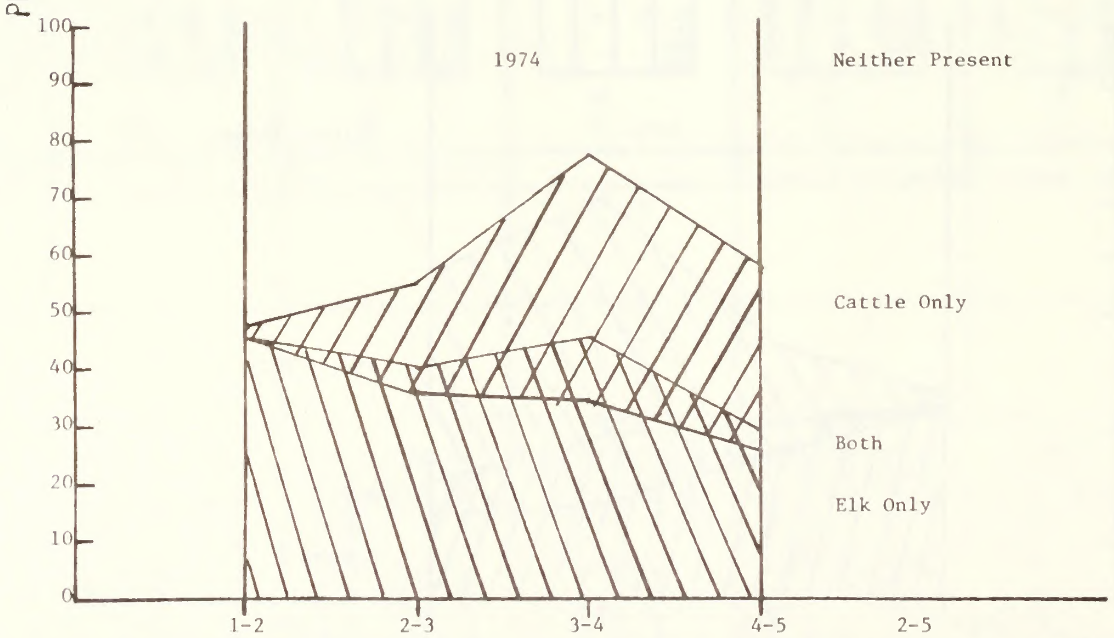
Runs of Route System with respective statistical values.
*Significantly Different P $\leq$ .05. **Highly Significantly Different P $\leq$ .01.

Figure 18. Proportion of route system used by elk and/or cattle for segments where elk sign was present the previous run for the summers of 1973 and 1974 based on the pellet group elk use method.



N/A	-.42	-.53	-.57	-.53	Coefficient of Association
N/A	.02*	.0000**	.0003**	.009**	Chi-square P - Value

Runs of Route System with respective statistical values.



N/A	-.51	-.46	-.73	-.54	Coefficient of Association
N/A	.006**	.0001**	.0001**	.009**	Chi-square P - Value

Runs of Route System with respective statistical values.
*Significantly Different P $\leq$ .05. **Highly Significantly Different P $\leq$ .01.

Figure 19. Proportion of route system used by elk and/or cattle for segments where elk sign was present the previous run for the summers of 1973 and 1974 based on the general impression elk use method.

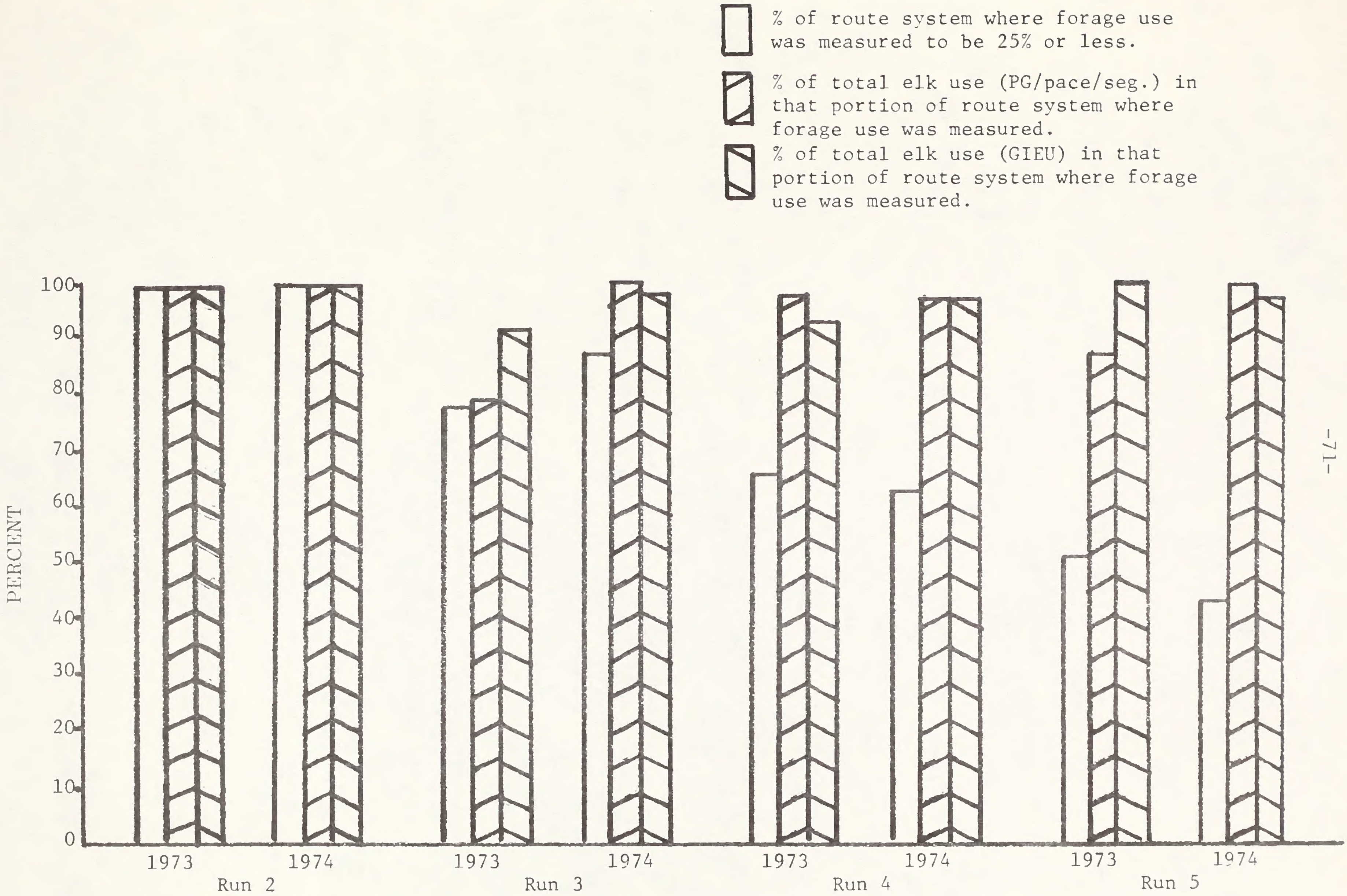


Figure 20. Percent of total elk use found in segments with recorded forage use of 25% or less.

47 percent of the route system fell into the 25 percent-or-less forage use category, it accounted for 96 percent of the total elk use recorded during that run. Most of the forage use in the study area can be attributed to cattle. Forage use in those segments where only elk use was recorded never exceeded 25 percent during 1973 or 1974.

Findings discussed in this section of the report strongly indicate negative interaction occurred between elk and cattle in the Long Tom Creek study area during the summers of 1973 and 1974. This negative interaction resulted in a displacement of elk by cattle that appeared to be initially caused by social intolerance of elk towards cattle. A progressively increasing potential for direct and indirect forage competition was apparent as the summer advanced and the cattle became more dispersed throughout the study area. Cattle distribution did not appear to be influenced by the presence of elk.

LITERATURE CITED

Cox, George W. 1970. Laboratory Manual of General Ecology. Wm. C. Brown Company.

Lonner, T. N. 1974. Montana Cooperative Elk-logging study. Job II-B, Long Tom Creek Study. pp. 51-83. Prog. Rept. January 1-December 31, 1973. 164pp.

Lyon, L. J. 1973. Montana Cooperative Elk-logging study. Job II-A, Burdette Creek-Deer Creek vegetation analysis. pp 7-25. Prog. Rept. for January 1-December 31, 1972. 172pp.

Mueggler, W. F. and W. P. Handl. 1974. Mountain Grassland and Shrubland Habitat Types of Western Montana. U.S.D.A. Forest and Range Exp. Stat. and Region I Interim Report. 89pp.

Pfister, et al. 1974. Forest Habitat Types of Montana, May 1974. U. S. Forest Service, Intermountain Forest and Range Experiment Station and Region I. 213pp.

Submitted By: Terry N. Lonner

JOB II - C
SAPPHIRE DIVIDE STUDY

PROGRESS REPORT FOR 1974 CALENDAR YEAR
July, 1975

INTRODUCTION

The last annual report for this study described the study objectives, study area, methods, and related publications. This report will be briefer and will be limited to: a) status of radioed elk since last report and observations on their movements, and b) the summary chapter of a doctoral dissertation by Les Marcum. Marcum's dissertation contains much information that is germaine to the original objectives of this study, as he describes quantitatively and in considerable detail the summer and fall habitat selection and use of this elk herd, this use occurring in areas that experienced considerable logging activity.

On August 31, 1974, we lost one of our fellow workers in a tragic airplane accident. Terry McCoy, a wildlife student, and the aircraft pilot were killed while tracking elk at the head of Welcome Creek. Terry had done most of the airplane tracking work in 1973 and 1974. For approximately a month following the accident, little data were collected. Prior to the general elk hunting season, however, we again picked up the usual flying routine for that time of year and followed all animals back to their winter range. The skill Terry developed for tracking elk was great, and the unusual movement of Elk A4, described later in this report, might not have been discovered without him.

FINDINGS

Radio Location of Elk

The last annual report presented a chart showing performance of radios on elk for the entire study through June, 1974 (see Figure 3 in that report). That chart thus included the 8 new elk radio-tagged in 1974 (Elk I, N, Q, X, Y, Z, A4, B4). All radios operating at that time continued to operate through the summer-fall season, although Elk F and Elk W both lost their collars in late fall. Bull Elk F had a solid acrylic collar which apparently was lost in late October, but not recovered. Although the radio continued to function through winter it was buried by early snows and couldn't be found in Fall, and stopped operating in spring. The collar from cow Elk W is still operating and was recovered near Cinnamon Bear Pt. in June. It was a plastic pipe collar and it broke near the base on the radio side.

Elk O, a cow that traveled almost to Missoula each of the last three summers, was apparently poached in late winter on the Threemile Game Range. Her collar was found intact, hanging on a tree, and is still operating after 41 months. It operated on her continuously for approximately 37 months.

Seasonal Movements

The summer of 1974 was another relatively moist summer, similar to 1972, and habitat use reflected this. There was considerable logging activity on the Arasta Creek Sale in Threemile Creek and we saw almost no use of the Threemile drainage by elk. There was much hot weather in August and we observed considerable elk use in the head of Welcome Creek, particularly Carron Creek. Although there appear to be shifts in habitat use from year to year, individual elk tend to be very consistent, from year to year, in the area of summer range they occupy. This consistency was very noticeable in 1974, including an old bull (Elk F). Elk V wintered on the Rock Creek side of the divide in 1973-74, but again wintered on the Threemile Game Range in 1974-75. Presumably in 1973-74 she was restricted from returning because of deep snows.

One very unusual movement occurred with a 2-year-old bull, Elk A4. In mid-July he moved north, almost to the Clark Fork river near Clinton. He then moved to Mt. Sentinel near Missoula and a few days later was found up the Rattlesnake Valley northeast of Missoula. After that he moved to the north side of the Rattlesnake Range where he spent most of the summer and fall. He wintered in the Jocko Valley east of the town of Arlee, some 40 miles north of his point of capture. This movement might represent a dispersal of a young male to an area entirely apart from the rest of his herd. He was observed with other elk in the Jocko drainage in fall and winter, and with cows on several occasions during the breeding season.

In 1974 we had no radio-tagged elk cross Rock Creek, although each of the three previous years we had one individual that occupied summer ranges just east of Rock Creek.

Summer-Fall Habitat Selection and Use

The following description is taken from Les Marcum's thesis titled Summer and Fall Habitat Selection and Use by a Western Montana Elk Herd, Ph.D. thesis, University of Montana, 1975. It is the entire summary chapter of that thesis.

CHAPTER VI

SUMMARY

The summer-fall selection and use of several biological and physical habitat factors by a western Montana elk herd were studied from 1971 through 1973 using radiotagged animals. The study area was in the Sapphire Mountains, about 20-30 miles southeast of Missoula, Montana.

Under prevailing conditions, elk used several habitat factors significantly in excess of the availability of those factors. Habitat conditions generally selected for by elk from June through November for the entire study period were identified as (1) *Pseudotsuga menziesii/Calamagrostis rubescens* (DF/Caru) and *Abies lasiocarpa/Galium triflorum* (AF/Gatr) habitat types, and less importantly, because of low elk use and availability, the riparian and shrub-graminoid plant communities; (2) slopes on southwest and south aspects; (3) gentle (0-15°) slopes; (4) drainage bottoms and upper slopes; (5) elevations of 5,350 to 6,349 feet from an available range of 3,850 to 7,900 feet; (6) an overstory canopy coverage of 26-75 percent; and (7) areas within 150 yards of water. Also, when in openings, elk selected for areas near timber. However, during each year of the study, environmental situations selected for by elk regardless of between-year variations were (1) the *Abies lasiocarpa/Galium triflorum* (AF/Gatr) habitat type, (2) drainage bottoms and upper slopes, (3) gentle (0-15°) slopes, (4) elevations of 5,850-6,349 feet, and (5) areas within 50 yards of water. The *Pseudotsuga menziesii/Xerophyllum tenax* (DF/Xete), *Abies lasiocarpa/Menziesia ferruginea* (AF/Mefe), and *Abies lasiocarpa/Xerophyllum tenax* (AF/Xete) habitat types were most important, respectively, in terms of total elk use, but were not selected for. Also, moderately steep (16-30°) slopes were most used, but total use did not exceed availability.

Elk preferred to feed in *Abies lasiocarpa/Galium triflorum* (AF/Gatr) and *Pseudotsuga menziesii/Calamagrostis rubescens* (DF/Caru) habitat types, on southwest aspects, on midslopes and drainage bottoms, on steep (> 30°) slopes, and within areas with 25 percent or less overstory canopy coverage except for clearcuts. Elk preferred to bed in *Abies lasiocarpa/Menziesia ferruginea* (AF/Mefe) and *Abies lasiocarpa/Xerophyllum tenax* (AF/Xete) habitat types, on north and northwest aspect slopes, on upper slopes and ridges, and within areas with greater than 75 percent overstory canopy coverage.

Substantial between-year and seasonal differences in habitat use and, in some cases, selection by elk were attributed to direct or indirect influences of weather. During 1971, spring moisture was near normal, but the summer was hot and dry. Spring precipitation was much higher than normal during 1972, and early summer weather was moderated by cool-moist periods. Nineteen-seventy-three was a drought year, and the summer was hot. During 1972, desiccation of plants was delayed, and all elk made greater use of relatively xeric plant communities, warm aspects, and areas with less than 25 percent overstory canopy coverage. Conversely, more mesic or hydric plant communities, cool aspects, and areas with greater than 25 percent overstory canopy coverage received less elk use during 1972. These relationships were reversed during the relatively warm, dry years of 1971 and 1973. Habitat use during the drought year of 1973 differed from habitat use during 1971 and 1972 mainly in that areas near water, and lower slopes received greater elk use in the summer of 1973.

Use of areas within 100 yards of an ecotone received more use than areas greater than 100 yards from an ecotone during 1972 and 1973, and 37 percent of total elk use during 1971; however, areas near an ecotone were selected for only during 1973.

Habitat use by elk from June through November varied substantially. Nearly all categories for each habitat factor examined received a greater percentage use by one or both sexes, and for one or more months, than the percentage occurrence of that habitat category within the study area. The only exceptions to the preceding statement were scree, clearcut, and talus plant communities; midslopes; steep (> 30°) slopes; and non-forested areas.

Cows made noticeably greater use than bulls did of plant communities at lower elevations; drainage bottoms; gentle (0-15°) slopes; areas with less than 25 percent oversotry canopy coverage; areas near ecotones; and areas near water, especially during June. Sexual differences in habitat use were related to giving birth and tending newborn calves.

The most important forage class for elk was forbs within the *Pseudotsuga menziesii/Symphoricarpos albus* (DF/Syal), *Pseudotsuga menziesii/Arctostaphylos uva-ursi* (DF/Aruv), *Pseudotsuga menziesii/Calamagrostis rubescens* (DF/Caru), *Pseudotsuga menziesii/Xerophyllum tenax* (DF/Xete), *Abies lasiocarpa/Xerophyllum tenax* (AF/Xete), and *Abies lasiocarpa/Vaccinium scoparium* (AF/Vasc) habitat types. Browse was most important in the *Pseudotsuga menziesii/Physocarpus malvaceus* (DF/Phma) and *Abies lasiocarpa/Galium triflorum* (AF/Gatr) habitat types. Browse and forbs were equally important within the *Abies lasiocarpa/Menziesia ferruginea* (AF/Mefe) habitat type. Graminoids were almost as important as forbs, for elk forage within the *Pseudotsuga menziesii/Calamagrostis rubescens* (DF/Caru) habitat type, and they were also important within the *Pseudotsuga menziesii/Physocarpus malvaceus* (DF/Phma), *Pseudotsuga menziesii/Symphoricarpos albus* (DF/Syal), *Pseudotsuga menziesii/Arctostaphylos uva-ursi* (DF/Aruv), and *Pseudotsuga menziesii/Xerophyllum tenax* (DF/Xete) habitat types.

During June and July, the most important elk forage was forbs, while browse was used most during August. From September through November the diet of elk was comprised mostly of graminoids. Ample forage was available throughout the summer-fall period, within the study area.

Open system roads and areas within 550 yards of open system roads were selected against by elk, the use of open spur and four-wheel drive trails did not differ significantly from availability, and closed roads were selected for. However, when open spur roads and four-wheel drive trails, and roads closed to four-wheeled vehicles were considered, elk selected against areas near roads only during 1971, the year of most intensive logging activity in the study area. Cows used areas on or near roads more than bulls did. Both sexes were found closer to roads during June, July, and November than during other months. The greatest use of lands 1 mile or more from the nearest open road occurred during October, the month when the general hunting season opened.

During autumn, elk were more often found near open roads and in open timber stands when hunting seasons were closed than when they were open. Much of the displacement of elk from open roads during hunting seasons was in excess of 1 mile. Moderately timbered areas were used about the same by elk in autumn during hunting seasons and when hunting seasons were closed. However, use of heavily timbered areas increased substantially during hunting seasons.

Clearcuts were selected against by elk throughout the study. Use of partially cut areas was not significantly different from their availability during 1971. However, partial cuts were selected for during 1972 and 1973. Elk tended to select against areas near clearcuts during 1971 and 1972, but not during 1973, when logging activity within the area was lowest. When all logged areas (clearcuts and partial cuts) were considered, areas in close proximity to cuts were selected against by elk only during the year of most intensive logging activity, 1971. Cows were found in close proximity to logged areas more often than bulls were. Bull elk were located on or near logged areas most often during June and November. Cows used such areas to the greatest extent during June and July, and during October and November.

Elk were displaced during summer and fall months by road building and logging when those activities occurred at higher elevations in major drainages. The animals were less disturbed in summer by logging which was initiated during the early spring at lower elevations on the winter range area, where the terrain was relatively gentle. Potential detrimental effects of road building and logging activities on elk can be mitigated by confining those activities to as small an area as possible during a given time period, and closing adjacent roaded drainages to traffic.

Elk avoided human activity, not the roads. Roading and logging an area, to the extent that these activities were carried out within the study area, will not long preclude normal levels of summer-fall elk use, except on the clearcuts themselves, when intensities of human activities are low. However, the use of such areas by elk can be further enhanced, even during hunting seasons, by closure of the roads to vehicular traffic. There also may be a biological justification for road closure, to prevent the possibility of an overharvest of that portion of the elk herd which ranges in closer proximity to roaded areas.

No measurable benefits accrued to elk within the study area as a result of clearcut logging. Elk were more tolerant of logged areas in which only a portion of the timber stand was removed; however, cuttings of this type above the winter range area did not contribute to the welfare of the elk herd. Conversely, since the pregnancy rate was high and the herd was increasing in numbers, there is no evidence that logging to date above the winter range was harmful in terms of elk productivity. Since the length of the hunting season is adjusted yearly to prevent a substantial overharvest of the elk herd, logged and roaded areas probably had a greater influence on the style, quality, and opportunity of hunting than they did on the welfare of the elk herd. However, rapid removal of the overstory from large areas could conceivably alter future conditions for elk, and may adversely affect productivity, especially if the elk continue to select against clearcuts. If continual deforestation eventually does alter summer-fall habitat adversely, road closures alone may not provide enough protection for elk in the future. Therefore as logging continues, care should be taken to insure that cover as well as forage needs of elk are met throughout the entire cutting cycle. Also, continuing studies should be carried out to define the rate at which logging can proceed without adverse effects on elk.

Biological and physical habitat situations which are consistently selected for by elk, and which appear to have the greatest potential for influencing herd productivity should remain unaltered where possible. Areas near water, such as drainages and drainage heads, coinciding especially with early to mid-seral stages of the Abies lasiocarpa/Galium triflorum (AF/Gatr) habitat type, and with the Abies lasiocarpa/Menziesia ferruginea (AF/Mefe) habitat type in some places, fall into this category. Also, it may be desirable to exclude from these situations within the high elevation forest zone in unroaded or closed areas. Elk make such wide use of the environmental situations available to them that the welfare of the herd cannot be disregarded on any substantial portion of the summer-fall range by land managers while formulating land use plans for an area. This being the case, land and wildlife managers should strive to protect critical areas, as previously described, and insure a juxtaposition of other environmental situations which are selected for or heavily used by elk, including moderate to dense timber stands on various aspects, on gentle (0-15°) to moderately (16-30°) steep slopes, on upper slopes, and within the major forested plant communities on the area. Other factors being equal, selectively logged areas will be more readily accepted by elk than clearcuts, and since elk exhibited a significant preference for remaining within 100 yards of timber stands when in open areas, clearcut openings probably should not be too large. Also, logged areas should be isolated from open system roads, and such roads should be located away from streams as far as possible to avoid excessive disturbance of elk.

DISCUSSION

Four years of intensive field work have been completed on the Sapphire study area. This has included work conducted prior to, during, and following several timber sales in the study area. It is anticipated that field work will be terminated after the 1975 or 1976 field seasons, as it appears that adequate data will be obtained by that time. Four graduate theses have been completed during the study. Other publications will be planned during the coming year.

Submitted by: R.R. Ream
C.L. Marcum

JOB II-D

CHAMBERLAIN CREEK STUDY

Progress Report for the Period
January 1, 1974 - December 31, 1974

INTRODUCTION

This study is designated to determine elk use of food and cover in an undisturbed summer range, and to measure the effects of logging disturbance on elk.

The study is broken into four basic procedures. Location of the study is shown in Appendix 1 Figure 1.

Procedure A

Collect timber production information for the preparation of an intensive stand inventory and analysis, and to prepare a comprehensive timber management plan based on findings from this and other studies conducted under the Inter-agency Cooperative Elk-Logging Research Project.

This procedure was completed during 1973 and has been amended during this reporting period.

Procedure B

Determine elk distribution in the study area, in relation to physiographic and vegetative variables. Measure elk use of proposed logging areas before, during, and after disturbance in order to determine resultant changes which occur in elk use.

Procedure C

Prepare a vegetative analysis of the study area. The purpose of this procedure is to establish relationships between elk use and the vegetative characteristics of the area, and to establish vegetative cover and composition for measurement of changes which occur as a result of timber management activities.

Procedure D

Obtain data concerning human use of the study area from on-the-ground observations, check stations and hunter interviews.

Field work on procedures A, B and C was started in the spring of 1971. Work under procedure D was started in 1972.

Information concerning use of the undisturbed habitat is complete at this time, with exception of transects to be installed on actual designated areas of proposed disturbance.

All data has been collected and much of the analysis has been completed concerning general distribution of elk in relation to vegetative and physiographic variables in the undisturbed study area.

A contract has been negotiated with the University of Montana to continue with the second phase of study, dealing with actual areas of disturbance.

STUDY METHODS

Collection of all data for determining the general distribution of elk in relation to vegetative and physiographic variables was made from transect lines divided into 4 chain (264 foot) segments. Appendix 1 (Figure 2).

Each segment of a line is treated as an individual systematic sample.

Forty-three miles of transect lines were measured on contours at two hundred foot elevation intervals.

An additional 9 miles of line was measured during this reporting period on 1300 acres of Burlington Northern and BLM land and added to the study area under a recent cooperative agreement with Burlington Northern. These transects were run at a compass bearing S 45^{o} W diagonally down the slopes. Data recorded in each 264 foot segment or individual sample along the transects includes:

1. Pellet count.
2. Percent vegetative cover.
3. Percent seconday cover (shrubs and trees 5-15 feet in height).
4. Percent canopy cover (shrubs and trees over 15 feet in height).
5. Vegetative composition of each stage of cover.
6. Composition of shrubs under 15 feet in height.
7. Composition of herbaceous understory.
8. Forest Habitat Types - from Habitat Types of Montana (Pfister et al 1974)
9. Percent slope
10. Elevation in hundreds of feet.
11. Aspect in eight compass points.
12. Number of tree stems-acre.
13. Average DBH of tree stems.
14. Distance to free water in 1/8 mile increments.

From this basic data, the following additional variables were computed:

1. Pellet density index.
2. Distance from nearest road.
3. Screening index of tree stems.
4. Moistures and temperature gradient of Forest Habitat Types (From table constructed by Pfister for Chamberlain Creek).
5. Distance from nearest adjacent Habitat Type.

Additional transects were measured at 1/4 miles intervals along the proposed "mainline" road. Each transect extends 1/2 mile either side of the road "P" line.

On an assumption that the primary effect of this road, if any, would be to reduce the security of the summer range, only elk pellet densities, Forest Habitat Types, and a screening or security cover index was recorded.

Security cover was quantified using a line transect. At each pace along the transects the nearest screening cover was recorded at 90° to the line. The distance to the visual obstruction and the diameter of the obstruction was recorded. An additional record was made for the distance at which the entire 1 pace (approximately 10 + 1 feet) part of the line was screened.

Computation of an index to visual obstruction is made in either of two ways.

1. A direct computation of the distance at which visual obstruction reaches 100 percent is used as an index.

   This is computed using the estimated distances at which vision is totally obscured at each sample point. The mean of these distances is the index for a 200 foot line segment.

2. Using the length of and distance to the nearest visual obstruction 90° from the transect line at each point, an angle of obstruction is computed for each point. An average angle of visual obstruction is computed for each 200 foot segment of line, and from this angle the distance at which the entire 200 foot segment is obstructed is computed. This distance of total obstruction is the index.

   This method is preferred because less personal judgement is involved. All field data can be collected accurately at whatever precision is required.

   Data has not been analyzed on these transects to date.

   Each 200 foot segment of transect for which a screening index is computed is also measured for pellet group concentrations and Timber Habitat Type.

Pellet deposition and screening index will be remeasured annually after the road has been constructed.

The study area was retyped for Timber Habitat Types after Pfister Habitat Types of Montana, 1974. These Habitat Types are shown in Appendix 1, Figure 3.

Pellet group densities were recomputed and are shown by zero, light, moderate, and high use levels. (Appendix 1, Figure 4). These levels were based on the first, middle and top 33 1/3 percentile for all plots containing elk pellet groups in the study area.

Elk movement in Chamberlain Creek has not been studied directly during the course of this project. To obtain some concept of how elk move through the drainage, elk trails were mapped. (Appendix 1, Figure 5.) These trails show significant movement patterns and resulted in modification of roads and cutting units in the Timber Management Plan for this study, as shown in Appendix 1, Figures 6, 7 and 8.

Data concerning general distribution of elk in relation to environmental variables described above were entered on a Data Deck for computer analysis.

This work took almost as many man hours as did the collection of data.

Data was summarized in numerous two-way tables for cursory evaluation.

From data summaries, each Timber Habitat Type was rated by preference demonstrated by elk use. This rating was computed by dividing the percent of total samples represented by any one habitat type in to the percent of total samples used by elk which fell in the same habitat type. As can be seen in Table #1, the percent of total elk use plots which fell in Habitat Type 330 was 2.99 times the percent of total plots which fell in that habitat type.

Table 1

Rank	ADP Code	Habitat Type	Preference Factor
1.	330	Psme/Cage	2.99
2.	321	Psme/Caru/Agsp	2.62
3.	632	Abla/Gatr/Caca	2.62
4.	323	Psme/Caru/Caru	1.59
5.	780	Abla/Arco	1.40
6.	271	Psme/Xete/Vagl	1.36
7.	650	Abla/Caca	1.26
8.	281	Psme/Vagl/Vagl	1.16
9.	670	Abla/Mefe	.94
10.	691	Abla/Xete/Vagl	.94
11.	662	Abla/Libo/Xete	.93
12.	292	Psme/Libo/Caru	.92
13.	720	Abla/Vagl	.68
14.	661	Abla/Libo/Libo	.37
15.	692	Abla/Xete/Vasc	.21

Vegetative species are listed by their percent occurance in each habitat type. Table 2 shows vegetative species and percent occurance by habitat type in areas in which elk pellets were found and where they were not. In some Timber Habitat Types, table differences in vegetation is evident when comparing area of no pellets to areas in which elk pellets were found.

Table II Vegetative compositions for areas containing elk pellets compared to those containing none for each Timber Habitat Type

Habitat Type	271		281		292		321		323		330		632		650	
Vegetative Species	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Abies lasiocarpa													2.9			
Acer glabrum			0.6		0.5											
Alnus sinuata													2.9	1.2	T	0.4
Amelanchier alnifolia		0.5			0.5							2.9				
Arctostaphylos uva-ursi	3.0	2.0			2.3				T	0.3					0.8	
Berberis repens	3.6	1.0			7.0	16.9	3.7	2.0	12.4	6.2		2.9				
Chimaphila umbellata	3.6	5.4	2.7	6.6	8.5	4.2			0.5	0.3					0.4	1.1
Juniperus communis			2.3	0.9								1.4			0.4	
Juniperus horizontalis																
Ledum glanduosom															3.6	5.6
Linnaea borealis	0.9	6.3	15.1	4.9	17.8	16.9	1.9		0.5					2.7	1.7	3.4
Lonicera Spp.					0.5				T							
Lonicera involucrata													2.9			
Lonicera utahensis	0.6														0.4	
Menziesia ferruginia			0.5											0.5	0.4	0.4
Pachistima myrsinites	1.5				2.3										T	
Picea engelmanni															T	0.4
Pinus contortus	0.3															
Physocarpus malvaceus																
Prunus virginiana					0.5											
Pseudotsuga menziesii																
Rhus Spp.														1.1		
Ribes Spp.			0.5												2.5	0.7
Ribes lacustre													2.9			
Rosa Spp.									0.5	0.6						
Rubus Spp.			0.9												1.0	
Rubus parviflorus														0.5	1.9	0.4
Salix Spp.			0.5						0.5				2.9		T	4.9
Sherperdia canadensis															T	
Sambucus melencarpa																
Spirea Spp.			0.9	16.4		2.8		2.5	1.6	0.6						
Spirea betuifolia	1.5	0.5			3.3		3.7	0.5	1.2	3.1	35.3	1.4			1.9	2.6
Symphoricarpas occidentalis	0.6						1.9		1.6	0.6		1.4				
Vaccinium globular	20.1	14.6	31.5	6.6	6.1				0.7				2.9		5.7	8.6
Vaccinium scoparium	4.0	2.0	3.7			1.4								15.9	1.7	7.9

Table II (continued)

Habitat Type	661		662		670		692		691		720		780	
Vegetative Species	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Abies lasiocarpa			T	T	0.3	0.3	T		T	T	T			
Acer glabrum			0.5	T	T				T	T	0.7			
Alnus sinuata	1.7	0.8	0.7	0.3	1.6	1.3	1.4		1.5	1.0				1.4
Amelanchier alnifolia	0.8		0.5	T	T				0.6		3.4	2.9		
Arctostaphylos uva-ursi		1.3	1.2	0.7	T	T	6.4	4.9	0.7				0.8	
Berberis repens	0.4		0.5	0.7					T	T	1.3	4.8		
Chimaphila umbellata	6.6	5.9	7.5	5.8	4.4	2.8	4.9	4.6	6.1	5.9		5.1	3.3	
Juniperus communis			0.3	T	T		T	T	0.6	T	2.0			
Juniperus horizontalis					T	T	T							
Ledum glanduosom					0.8.	0.6			T					
Linnaea borealis	17.4	16.7	12.8	10.3	3.1	2.4	T	T	0.3	T			0.8	1.0
Lonicera Spp.	0.4	1.3	0.6		T	T	T	T		T	0.4			
Lonicera involucrata			T		T				T					
Lonicera utahensis									T					
Menziesia ferruginia		0.4	T	0.6	8.	10.4	T	T	T	0.3	T			
Pachistima myrsinites	7.1	4.6	5.4	1.1	T	T			0.6	0.5	4.0			1.0
Picea engelmanni									T	T				
Pinus contortus			T		T		T		T		T			
Physocarpus malvaceus			T						T					
Prunus virginiana														
Pseudotsuga menziesii			T	0.3	T	T			T	T				
Rhus Spp.						T								
Ribes Spp.			0.5		0.9	T	T		0.3	0.4	3.4	1.0		
Ribes lacustre			T		T		T	T	T	T	0.7		0.8	
Rosa Spp.			T											
Rubus Spp.					0.9	T			T	T	1.4			
Rubus parviflorus			0.8	T	1.2	T			0.3	0.6	1.6	1.0	1.7	
Salix Spp.				T	T				T	T	1.8	1.0		0.5
Sherperdia canadensis				T	T				T	T	0.4			
Sambucus melencarpa					T	0.3								
Spirea Spp.	5.8		2.1	1.0	T		0.4	1.1	1.2	1.4	2.0			
Spirea betuifolia		0.4	0.6		T		0.5	0.5	1.7	3.1	5.0	1.9	0.8	1.0
Symphorcarpas occidentalis			T	T							T			
Vaccinium globular	7.1	6.7	13.1	8.2	8.8	5.7	2.9	2.9	19.8	15.6	29.5	27.9	0.8	1.0
Vaccinium scoparium	0.8	5.0	5.8	11.4	7.5	11.2	49.8	54.4	16.2	12.2	6.3	17.3		

Table II

Vegetative compositions for areas containing elk pellets compared to those containing none for each Timber Habitat Type

Habitat Type	271		281		292		321		323		330		632		650	
Vegetative Species	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Actaea arguta														0.5		
Achillea lanulosa	0.3	1.0			1.4		1.9	2.0	T	2.5	17.6	5.7			1.0	0.4
Antennaria Spp.																
Arnica cordifolia	19.5	20.5	5.5	42.6	3.3	4.2			3.8	3.7			44.1	41.2	21.3	6.4
Aster integrifolius															1.0	
Aster Spp.	0.9			1.6		7.0			3.8					3.3		
Carex Spp.															1.7	1.1
Carex concinnoides			0.9						0.9						1.1	0.7
Carex geyeri	0.3	1.5	2.3	1.6	1.4		24.1	15.3	7.5	16.8	11.8	40.0				
Calamagrostis rubescens	6.7	19.5	14.2	9.8	24.9	29.6	37.0	33.2	50.9	54.2		2.9			1.0	
Cyperus Spp.																0.4
Equisetum Spp.														1.1	6.1	0.4
Fragaria Spp.	2.4	0.5			0.5	1.4			4.5	2.2					1.9	1.5
Festuca idahoensis							13.0	10.9	0.5	0.6	5.9	7.1				
Festuca scaberella					0.5		1.9	1.0				4.3				
Fungi																
Galium triflorum					0.5				0.5	0.3	5.9		2.9	3.3	1.0	
Koeleria cristate																1.5
Lupinus candatus				1.6	0.9		1.9	0.5		1.2					1.1	
Lupinus Spp.									0.5	0.6						
Pastinaca sativa																0.4
Plantago Spp.	0.6															
Pteridium Spp.										0.3				0.5	T	
Pyrola Spp.	2.1	0.5	0.9	3.3	1.4	7.0			T	0.3				3.3	1.3	0.4
Pyrola asarifolia				1.6		4.2				0.3						2.2
Saxifraga arguta																
Saxifraga Spp.			8.7		0.5										0.4	
Scirpus Spp.															1.3	
Smilancina racemosa															0.4	
Smilancina stellata														0.5		
Stipa Spp.															1.9	3.4
Tiarella unifolata														2.2	1.1	
Thalcitrum alpinum	5.9	0.5			0.5				1.9	0.9				4.4	1.3	1.5
Trillium ovatum																
Viola arvensis					1.9			0.5					14.7			
Veratrum viride														2.2		
Viola species	0.9		0.5	3.3	0.9		1.9	3.0	2.8	1.9	5.9			2.2	0.7	3.2
Viola orbiculata	0.9	1.0	1.4		1.4						5.9	1.4				T

Table II — Vegetative compositions for areas containing elk pellets compared to those containing none for each Timber Habitat Type

Habitat Type	271		281		292		321		323		330		632		650	
Vegetative Species	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Xerophyllum tenax	21.8	17.1	0.5		2.8		1.9		0.5	0.6		4.3	2.9	0.5	1.9	1.5
Agropyron spicatum							3.7	0.5		0.3						
Allium Spp.							1.9	1.5								
Calamagrostis canadensis		2.0				1.4					5.9		2.9	13.2	23.4	39.7
Goodyera Spp.		0.5						2.0		0.3	1.4					

Table II (continued)

Habitat Type	661		662		670		692		691		720		780	
Vegetative Species	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Actaea arguta									T	T				0.5
Achillea lanulosa					T		T		T	T				
Antennaria Spp.						T			T	T				
Arnica cordifolia	36.1	32.2	22.7	32.0	37.4	42.5	6.8	9.7	21.4	28.1	6.1	12.5	64.4	77.0
Aster integrifolius						T				T				
Aster Spp.	0.8	1.3	T		T	T	T		T	T	T			
Carex Spp.			T		0.5						0.5			
Carex concinnoides	0.4	0.4	0.4	T	0.5	0.5	1.3	1.1	0.3	0.3	2.7	2.9		
Carex geyeri		2.1		T							1.8			
Calamagrostis rubescens	7.5	2.5	4.0	1.5	T	1.3	1.6	1.4	0.4	0.9	12.3	16.3		
Cyperus Spp.														
Equisetum Spp.					0.3	T			T					
Fragaria Spp.	0.8		T		T	T		T	T		0.4			
Festuca idahoensis														
Festuca scaberella											T			
Fungi							T							
Galium triflorum		0.8	T		T	T				T				
Koeleria cristata														
Lupinus candatus										T				
Lupinus Spp.	0,8		T	T				0.8	T					
Pastinaca sativa														
Plantago Spp.														
Pteridium Spp.					T	T								
Pyrola Spp.	4.6	5.9	3.3	2.5	3.4	2.8	T	0.9	1.2	1.6			2.5	0.5
Pyrola asarfolia			0.4	T	1.1	0.7		0.5	1.0	1.6	T	6.7	5.1	1.9
Saxifraga arguta					T				T	T				
Saxifraga Spp.	0.4		1.7	0.3	T			T	0.5		2.0			
Scirpus Spp.														
Smilancina racemosa					T				T	T				
Smilancina stellata									T					
Stipa Spp.														
Tiarella unifolata		0.8			0.6	0.5			T	T				1.9
Thalictrum alpinum	1.2	1.3	0.5	0.9	0.6	0.9	T		0.5	1.0	0.4		1.7	2.4
Trillium ovatum		0.8			T	T								
Viola arvensis		0.4	0.6		T	T			0.3	1.0	0.4			2.4
Veratrum viride		0.8	T		0.3	T			T	T			2.05	0.5
Viola species		1.3	0.5	0.3	0.3		0.3	T	0.5	1.3	1.1	1.0		
Viola orbiculata	0.8	3.3	0.5	1.9	1.7	2.4	0.9	0.7	1.1	1.1			1.7	3.3

Table II (continued)

Habitat Type	661		662		670		692		691		720		780	
Vegetative Species	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P	NP	P
Xerophyllum tenax	2.5	1.3	10.8	18.4	9.2	11.2	20.9	16.0	20.1	19.3	1.3		2.5	0.5
Agropyron spicatum														
Allium Spp.														
Calamagrostis canadensis		1.3			0.7	0.4	T		T	T				
Goodyera Spp.				T										

Table 2. Vegetative Composition of Timber Habitat Types

> Summaries showed no obvious direct relationships between physiographic variables and elk use. The notable differences in vegetative communities in relation to elk use within Habitat Types suggested that physiographic variables did influence elk at least to the extent that slope, aspect, canopy, moisture, etc., influence vegetative composition within a given Habitat Type. Different effects of these physiographic variables between Habitat Types dampen the correlations drainage wide.

Because of the great variation in species present, vegetative communities below Timber Habitat Type, and phase is difficult to describe in a manner in which individual plots could be identified for the purpose of Automatic Data Processing.

Assuming that these communities are influenced by variables which may influence micro-climates, such as slope, aspect, tree stems per acre, timber canopy, etc., and that none of those variables had strong one-to-one correlations with elk use, a regression analysis was felt to be the only means of evaluating these influences. The assumption is that if vegetation influences elk use, and certain variables influence vegetation, then some combinations of these variables will indirectly influence elk use.

Variables used in the regression are:

*Y Elk pellet densities

X_1 = Reciprocal of slope in percent

X_2 = Aspect as a deviation from south in 8 points

X_3 = Screening index of tree stems in diameter/acre.

X_4 = Percent canopy cover

$X_5 = X, X_3$

$X_6 = X_3^2$

$X_7 = X_4^2$

X_8 = distance from nearest adjacent Habitat Type

X_9 = Temperature of adjacent Habitat Type.

X_{10}= Moisture of adjacent Habitat Type

$X_{11} = X_9 X_{10}$

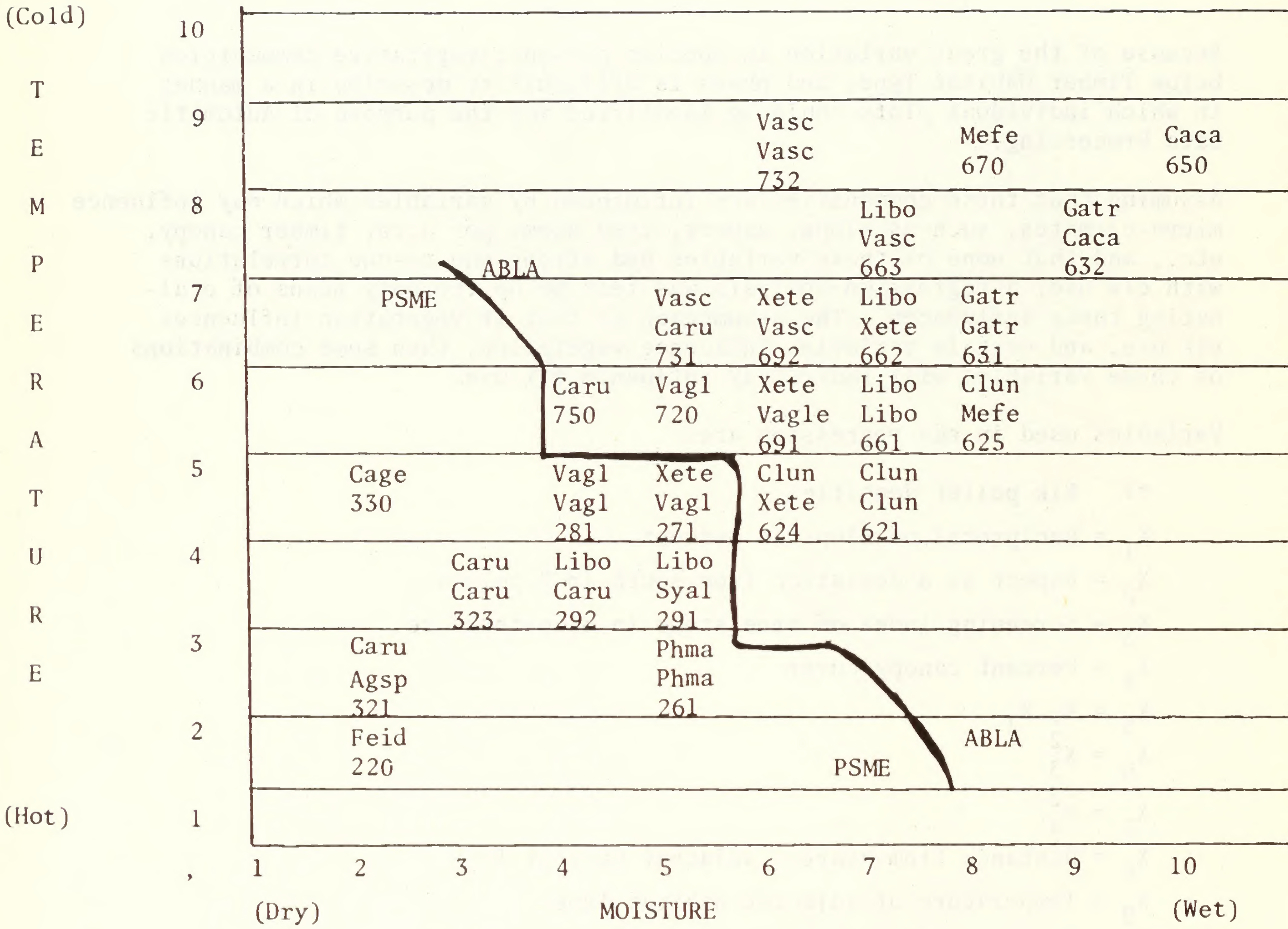
* Only plots containing elk use are employed in regression analysis.

Plots containing zero values for the dependent variable were excluded from the analysis because these plots implied an observation of elk use which, in fact, did not occur. Deletion of the zero value insured that all samples used in analysis had an actually observed and quantified value for elk use.

Figure 1

RELATIVE TEMPERATURE-MOISTURE RANKING

FOR HABITAT TYPES IN CHAMBERLAIN CREEK



NOTE: DF/ARCO and AF/ARCO are not plotted because the points likely were minor areas within other types. The ARCO types are typical dry continental climates in Southwestern Montana

R. Pfister 7/75

This deletion reduced the number of observations which were valid for inclusion in regression analysis. When using only plots which were used by elk, it was found the six Timber Habitat Types had insufficient samples to be statistically meaningful and were not included in the analysis.

Timber Habitat Types analyzed for elk use by the eleven independent variables from Page 11 are shown in Table 3.

Table 3: Timber Habitat Types analyzed for physiographic and vegetational characteristics in relation to elk use. Types are listed in order of preference based on availability in Chamberlain Creek

Rank	ADP Code	Habitat Type	Preference Factor
1.	323	Psme/Caru/Caru	1.59
2.	780	Abla/Arco	1.40
3.	271	Psme/Xete/Vagle	1.36
4.	650	Abla/Caca	1.26
5.	670	Abla/Mefe	.94
6.	691	Abla/Xete/Vagl	.94
7.	662	Abla/Libo/Xete	.93
8.	292	Psme/Libo/Caru	.92
9.	692	Abla/Xete/Vasc	.21

All environmental variables X_1........X_8 were measured or computed from raw data taken directly in the study area.

Variables X_9, X_{10}, and X_{11} were computed from estimates of relative moisture and temperature prepared by R. Pfister 7/75, Figure 1.

Environmental variable X_9 is a means of measuring the location of the pellet group in relation to temperature by assigning a temperature value to the adjoining habitat type which is closest to the pellet observation.

Variable X_{10} expresses moisture in the same manner as X_9 expresses temperature.

Variable X_{11} is a multiplicative interaction between moisture and temperature as determined from Figure 1.

FINDINGS

Linear Correlation Matrixes, Table 4, show some notable correlations between environmental variables, X_1 ....X_{11}, and pellet density indices (variable Y) in each timber habitat type.

Elk use appears to correlate somewhat with more shallow slopes in Habitat Types 271, 650, 662, 692, and 780. No strong direct correlations were found with steep slopes in any of the habitat types analyzed.

Aspect appears to affect elk use strongly only in Habitat Type 780, with some indication of preference for more southerly exposures. Some indication of affinity for southerly exposures is also apparent in Habitat Types 271 and 662.

Table 4 Linear Correlations between variables within each Timber Habitat Type in Chamberlain Creek

Timber Habitat Type 271 Psme/Xete/Vagle

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	-0.0726	-0.2185	0.1330	0.0494	-0.2120	0.1078	-0.0392	-0.3268	-0.2915	-0.3766	0.4891
	1	-0.3069	0.3449	-0.3302	-0.2675	0.2816	-0.4362	-0.2226	-0.2720	-0.2377	-0.2379
		1	0.0181	0.9396	9.9745	-0.0271	0.6922	0.1916	0.1900	0.1814	-0.3671
			1	0.0748	0.9238	0.9905	-0.0960	-0.6167	-0.6073	-0/5852	0.0684
				1	0.8819	0.0246	0.7475	0.0242	0.0323	-0.0037	-0.1542
					1	-0.0229	0.5978	0.1971	0.1921	0.1914	-0.4273
						1	-0.1370	-0.6060	-0.5969	-0.5680	0.1334
							1	0.1684	0.1631	0.1539	-0.0072
								1	0.9847	0.9942	-0.1399
									1	0.9859	-0.1326
										1	-0.1380
											1

Timber Habitat Type 780 Abla/Arco

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	0.1780	-0.4820	-0.0399	0.4267	-0.5004	-0.0627	∞	0.2786	0.4317	0.3376	0.5606
	1	0.1101	-0.5660	0.3726	0.1317	-0.5360	∞	0.5936	0.6825	0.6093	-0.3209
		1	0.4005	0.5642	0.9942	3.3638	∞	0.1549	0.0505	0.1199	-0.4909
			1	0.3717	0.3856	0.9914	∞	-0.0584	-0.1250	-0.0527	-0.0969
				1	0.5392	0.3352	∞	0.4471	0.5022	0.4764	-0.1372
					1	0.3521	∞	0.1444	0.0447	0.1084	-0.4723
						1	∞	-0.0621	-0.1154	-0.0494	-0.1635
							∞	∞	∞	∞	∞
								1	0.9666	0.9946	-0.0732
									1	0.9853	-0.0235
										1	-0.0669
											1

Table 4 (Continued)

Timber Habitat Type 692 Abla/Xete/Vasc

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	0.1593	-0.0901	0.0379	0.9070	-0.1060	0.0347	0.1211	-0.0090	0.0508	-0.0083	0.3625
	1	0.1672	-0.0226	0.1132	0.2326	-0.0643	-0.4628	0.2360	0.2748	0.2079	-0.0876
		1	0.1122	0.3022	0.9703	0.1131	0.0624	0.1744	0.1487	0.1543	0.0401
			1	0.1098	0.1889	0.9839	-0.2952	0.1383	0.1510	0.1582	0.1279
				1	0.2709	0.1051	0.1692	0.0033	0.0429	-0.0070	0.3635
					1	0.2006	-0.0342	0.1758	0.1624	0.1578	-0.0162
						1	0.2840	0.1158	0.1370	0.1292	0.1168
							1	0.1006	-0.0067	0.0659	0.2032
								1	0.9619	0.9796	0.2182
									1	0.9787	0.3144
										1	0.2812
											1

Timber Habitat Type 691 Abla/Xete/Vagl

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	-0.1052	0.0292	0.1747	0.6602	0.0835	0.2340	-0.1428	0.0531	0.0106	0.0281	0.1681
	1	-0.0471	-0.1315	-0.0509	-0.0486	-0.1615	-0.0519	0.2722	0.2361	0.2656	-0.0461
		1	0.1235	0.5277	0.9322	0.1016	0.0496	0.0521	0.0006	0.0113	-0.0071
			1	0.2121	0.1205	0.9761	-0.0249	-0.0559	-0.1022	-0.0837	0.0937
				1	0.6713	0.2642	-0.1241	0.0255	-0.0186	-0.0067	0.0696
					1	0.1230	0.0413	0.0579	0.0139	0.0208	-0.0334
						1	0.0247	-0.0533	-0.0988	-0.0820	0.0920
							1	-0.1980	-0.2447	-0.2178	0.0316
								1	0.9402	0.9737	-0.1084
									1	-0.9836	-0.1113
										1	-0.1045
											1

Table 4 (Continued)

Timber Habitat Type 670 - Abla/Mefe

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	-0.0844	0.0880	0.08780	0.9280	0.0861	0.0779	-0.1186	0.2146	0.2443	0.2301	0.0951
	1	-0.0526	-0.0415	-0.0963	-0.0155	-0.0111	0.3256	0.0458	0.0719	0.0584	0.0860
		1	0.0382	0.3830	0.9562	0.1290	-0.0941	0.0280	-0.0395	-0.0147	-0.0353
			1	0.0662	0.0058	0.9735	0.0944	-0.0730	-0.1213	-00939	0.0280
				1	0.3976	0.0998	-0.1099	0.1999	0.2211	0.2094	0.0087
					1	0.1192	-0.0413	0.0963	0.0341	0.0558	-0.0682
						1	0.1411	-0.0524	-0.0990	-0.0719	0.0101
							1	-0.1316	-0.1011	-0.1053	-00.1455
								1	0.9149	0.9723	0.3929
									1	0.9799	0.2426
										1	0.2990
											1

Timber Habitat Type 662 Abla/Libo/Xete

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	-0.2880	0.2202	-0.1876	0.6410	0.1807	-0.1789	-0.2042	0.4627	0.4632	0.4997	0.4927
	1	-0.0193	0.3573	-0.1212	-0.0618	0.3873	0.0883	-0.2098	-0.1654	-0.2087	-0.2843
		1	-0.1769	0.8500	0.9300	-0.1873	-0.1981	0.3188	0.2225	0.2737	-0.0056
			1	-0.1957	-0.1440	0.9828	0.0342	0.0949	0.0886	0.0918	0.0012
				1	0.8192	-0.2029	-0.1940	0.4401	0.3378	0.4175	0.1304
					1	-0.1637	-0.1436	0.2671	0.1826	0.2390	-0.1111
						1	0.0098	0.1257	0.1149	0.1189	-0.0171
							1	-0.1106	-0.0654	-0.1130	-0.1176
								1	0.8451	0.9736	0.0110
									1	0.9209	0.0545
										1	0.0062
											1

Table 4 (Continued)

Habitat Type 650 Abla/Caca

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	0.3173	0.1190	-0.0962	0.9132	0.0851	-0.0241	0.7643	0.0977	-0.0460	0.0209	0.6443
	1	-0.5500	0.2339	0.1069	-0.6375	0.3329	0.3101	-0.2256	-0.2382	-0.2403	0.1432
		1	0.0526	0.4229	0.9758	-0.0896	0.1079	0.5422	0.5062	0.5220	-0.0607
			1	0.0241	0.0226	0.9642	0.4566	-0.1764	-0.2245	-0.2115	-0.3367
				1	0.3766	-0.0058	0.7366	0.2434	0.1121	0.1707	0.5377
					1	-0.1157	0.0441	0.5043	0.4424	0.4699	-0.0850
						1	0.5252	-0.2487	-0.3054	-0.2866	-0.2879
							1	-0.0364	-0.1284	-0.0868	0.5032
								1	0.9593	0.9885	0.2949
									1	0.9906	0.2518
										1	0.2822
											1

Habitat Type 323 Psme/Caru/Caru

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	-0.0832	-0.0322	-0.1669	0.5786	0.0281	-0.2220	0.0219	-0.0180	0.0474	-0.0197	-0.1097
	1	-0.1172	0.1884	-0.0379	-0.1086	0.2601	0.0552	-0.2458	-0.1520	-0.1545	0.0038
		1	0.1344	0.7460	0.9840	0.1317	-0.2763	0.3880	0.3068	0.3151	-0.1081
			1	-0.0083	0.1051	0.9857	-0.1315	-0.1161	0.0101	-0.0861	-0.0870
				1	0.6503	-0.0328	-0.1886	0.2616	0.2430	0.2074	-0.1868
					1	0.1088	-0.2820	0.3196	0.2672	0.2569	-0.1106
						1	-0.1517	-0.1688	-0.0179	-0.1184	-0.0596
							1	0.0480	-0.0778	-0.0030	0.1031
								1	0.9133	0.9616	-0.1071
									1	0.9658	-0.0891
										1	-0.0732
											1

Table 4 (Continued)

Habitat Type 292 Psme/Libo/Caru

X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	Y
1	0.1853	0.0563	-0.1417	0.5521	0.0855	-0.1754	-0.4630	-0.5883	0.4828	0.2933	0.0558
	1	0.4349	-0.2257	0.4000	0.3423	-0.1611	0.2000	0.4472	0	0.1285	0.0118
		1	0.6329	0.8592	0.9906	0.6969	0.1089	-0.2457	-0.2222	-0.2835	-0.4057
			1	0.4570	0.6503	0.9948	0.4526	-0.4046	-0.2778	-0.3823	-0.4670
				1	0.8766	0.4932	-0.2085	-0.5464	0.0756	-0.0846	-0.2976
					1	0.7108	0.0142	-0.3242	-0.1502	-0.2371	-0.3560
						1	0.4466	-0.3642	-0.2966	-0.3887	-0.4681
							1	0.4472	-0.4472	-0.2998	-0.3106
								1	0	0.2873	-0.4188
									1	0.9578	0.8747
										1	0.9581
											1

Screening index of tree stems seem to correlate somewhat in some Habitat Types. Elk apparently prefer less screenining in Types 271, 292, and 780. These are all dryer types, either Douglas-fir or the dryer end of the Alpine fir. No positive correlation with screening index of tree stem was found.

Canopy Cover correlates somewhat with elk pellet densities in Habitat Types 650 and 292 where elk appear to prefer more open sites.

Elk pellet densities correlate with multiplicative interaction between slope and screening index in Habitat Types 650 and 692 on shallow slopes with higher screening and the shallow slope apparently the over-riding factor. In Habitat Type 292, there is a slight negative correlation with this variable. In this case, percent slope appears insignificant in the interaction; in fact, the interaction correlation is less, by far, than the negative correlation for screening index alone.

Variable X_6 (X_3^2) correlates slightly better with Y in most Habitat Type than does variable X_3,

Significant increases are evident in Habitat Types 271 and 662. A slight decrease in correlation occurs in Type 292. The rest of the Habitat Types show very poor correlation between either X_3 and X_6 and Y. In general, over the entire drainage, X_6 (screening index)^2 appears to be a better fit than the linear variable X_3 (screening index).

Variable X_7 (canopy cover)^2 or X_4^2 appears to correlate better than the linear X_4 in Habitat Types 271, 780, and 292. The only type in which the X_7 (X_4^2) correlate less than X_4 is in Habitat Type 650. No significant effect is apparent in other habitat types.

Variable X_8 (distance to nearest adjoining Habitat Type) appears to be important in Habitat Type 650 and 292. In 292 elk use appears to increase closer to the edge of the Habitat Type, whil in 650 the opposite is indicated. Variable X_9 (termperature of adjacent Habitat Type) appears to correlate strongly with Y in Types 292 and 670, with slight correlation in Types 692 and 605. Elk use in other types show little correlation with this variable when considered by itself. Moisture of adjoining type (variable X_{10}) shows very high correlation in Type 292, significant correlation appears evident in Types 692, 670 and 650.

A multiplicative interaction between variables X_9 and X_{10} (variable X_{11}) appears to correlate exceptionally strong in Type 292 and correlates significantly in 650, 670 and 692.

Judging from correlations of variables X_9, X_{10}, and X_{11} with Y, Habitat Type 292, 650, 670, and 692 appear to be used in relation to cooler temperature and higher moisture.

The above description of apparent interrelationship between Y and chosen environmental variables only suggests possibilities of factors which may influence elk use within given Timber Habitat Types.

Descritpion of interactions between Habitat Types is attempted by the correlations in Table 5, which measure the relationship between elk pellet densities and the distance to the nearest habitat type. An assumption is made that if elk use in a given Timber Habitat Type increases with the distance from an adjoining type, then the attraction of the adjoining type or edge between types is not as great as that of the type in which the sample is taken.

Table 5 shows two different correlations: 1. elk pellet group density indices, including zero indices, correlated with distance from the nearest adjoining type, and 2. elk pellet group density indices, excluding zero indices, correlated with distance from the nearest adjoining type.

Direct analysis of this variable is difficult, but some relationships between elk use and distance from the adjoining type can be seen through inference.

With elk pellet group density indices of zero included, a trend in pellet density indices where pellets actually occured may be obscured by the location of the zero indices, at either the shorter or longer distances from the adjoining type. The only time this would not occur is when the zero indices are uniformly distributed in relation to the distance. If the majority of zero indices occurred at the shorter distance, it would reinforce a negative correlation of plots containing use. If the zeros occurred at the longer distances, they would cancel a negative correlation of the plots actually used.

With density indices of zero deleted, the trend in elk pellet densities becomes more obvious as correlated to distance from the adjoining Habitat Type. However, whether the plots containing actual elk use occurred at a great distance from the adjoining type, or very close to the adjoining type, the correlation would be much the same.

This can be demonstrated in Table 5, where there are 6 samples taken in Habitat Type 271, two of which are pellet group density indices of zero.

Samples in Habitat 271, which include only plots containing elk pellets, show a slight negative correlation -.1626 with the distance from Habitat Type 272, indicating that in plots containing elk pellets, the densities of the pellet groups decreased slightly, as the distance from Type 272 is increased. This correlation is reinforced when the zeros are added, giving a stronger negative value of -.4834 indicating that the majority of the zero use plots fell at the greater distances from Type 272.

This would indicate a definite tendancy for elk to use Habitat Type 271 in higher concentrations closer to Habitat Type 272. This could be construed as a preference for Habitat Type 272 over 271, or it may mean that the "edge" between the types is of more importance than the type itself.

In this report a complete analysis of Table 5 is not intended. This analysis is made to explain the interactions between the correlations and to demonstrate that elk use is apparently influenced by the interspersions of Habitat Types in Chamberlain Creek. Elk also display preferences for individual habitat types as expressed in Table 1.

Table 5 Correlations between elk pellet densities in a sampled Timber Habitat Type and the distance to the nearest adjoining type

			Correlations		
H.T. Sampled	Adjoining H.T.	N	All Plots	N	Plot w/elk pellet Index > 0
271	272	6	-0.483393	4	-0.162671
271	662	4	0.816497	3	1.
271	691	8	9.86656E-2	4	-0.440921
292	323	5	-0.525471	Insufficient Sample	
292	330	3	0.	3	-1.
323	271	7	-0.453536	Insufficient Sample	
323	292	7	8.28370E-2	4	0.544336
323	312	3	0.944911	3	0.944911
323	321	7	-0.331127	Insufficient Sample	
323	330	4	-0.514946	4	-0.514946
650	663	3	0.99682	3	0.99682
650	670	5	-0.395288	Insufficient Sample	
650	691	8	1.96855E-5	4	6.68264E-5
662	271	5	-0.177159	5	-0.177159
662	323	5	0.477093	4	0.301622
662	621	3	-5.76650E-2	3	-5.76650E-2
662	661	13	-0.158148	5	-0.589881
662	670	17	-0.205754	11	-5.41255E-2
662	691	19	7.72752E-2	9	-3.33768E-2
662	692	8	-0.491597	4	-0.679324
670	631	6	0.554829	2	1.
670	632	5	-0.706414	4	-0.739555
670	650	9	-7.19412E-2	6	-0.577501
670	662	18	0.408212	8	0.494879
670	670	2	1.	2	1.
670	691	81	-9.18135E-3	48	-0.185041
670	692	8	-7.33655E-2	5	-0.348992
670	780	7	-0.232896	3	0.817059
691	281	4	-0.939336	4	-0.939336
691	323	3	-0.5	Insufficient Sample	
691	632	5	-0.474342	Insufficient Sample	
691	650	13	-0.368855	5	-0.513934
691	661	7	-0.389249	Insufficient Sample	
691	662	49	-6.80554E-2	25	0.122537
691	670	81	7.68796E-4	30	-0.143435
691	692	71	-8.17791E-3	36	-4.44617E-3
691	720	47	0.367919	31	0.298541
691	780	25	-0.156394	12	7.03189E-2
692	323	4	0.82721	3	0.952217
692	650	5	0.701496	3	1.
692	662	6	-0.4	Insufficient Sample	
692	670	10	0.327327	Insufficient Sample	
692	691	34	9.19531E-2	11	0.251949
720	691	11	1.09745E-2	5	-0.396431

These apparent preferences for individual Timber Habitat Types and for interspersions between Habitat Types give rise to questions pertaining to which environmental variables may best describe these preferences.

In an attempt to describe environmental variables influencing elk use within Timber Habitat Types or in relation to the interspersions, the variables listed on page 11 were correlated with elk pellet density indices by use of step-wise regression analysis.

Data sets where elk pellet density indices were zero are deleted from the data deck. These zero measurements were approximately 50 percent of the total observations.

Such a high quantity of constants would skew the distribution of the dependent variable, thus violating the required assumption of a normal distribution of Y. Such a violation would make regression analysis invalid.

Deletion of the data sets where Y is zero does not affect the validity of this analysis providing that: 1. the equation is used only to describe areas which elk are known to occur, or 2. the equation is used to predict areas of highest concentrations of elk pellet groups. Analysis of data sets containing no record of elk use must be made by a means other than regression. Such an analysis would be desirable at a future date.

After deletion of the data sets where Y is zero, only nine Timber Habitat Types retained sufficient sample size for inclusion in the analysis. These by order of preference factor are listed on page 12.

Correlations between elk pellet group densities on plots used by elk and environmental variables $X.......X_{11}$ in Timber Habitat Type 271 is shown in Table 6.

Table 6 - Regression Summary for Timber Habitat Type 271
Psme/Xete/Vagl
Number of Data Sets: 15

Variables	Beta Coefficients	Improvement in $(R)^2$	Accumulative $(R)^2$
X_o	.441755	----	----
+ X_1	6.18671	.239254	.239254
+ X_6	-.219343	.109675	.348929
+ X_2	-.000802648	.097599	.446528
+ X_5	60.1612	.06733	.513858
- X_1	6.18671	-.03349	.480368
- X_6	-.219343	-.001809	.534697

Residual Mean Square - .04247
Standard error of Y - .206082

Table 6 indicates relatively high correlations in Habitat Type 271, with variables X_2, X_5 and X_3 in order of entry into the equation. R^2 is relatively good at .535 and a close fit is indicated by the low value of the residual mean square.

Variable X_2 (aspect in points of deviation from South) appears as the most important variable in this Habitat Type. Reference to Table 4 shows a negative correlation between X_2 and Y indicating a preference toward southerly exposures. Variable X_5 $(\frac{\text{screening index of tree stems}}{\text{percent slope}})$ appears as the second important variable in the final equation. From Table 4 this correlation is also negative, indicating preference for steeper slopes, more open timber stands or a combination of the two. Variable X_3 (screening index of tree stems) increases the fit.

Table 7 - Regression Summary for Timber Habitat Type 292
Psme/Libo/Caru
Number of Data Sets - 6

Variables	Beta Coefficients	Improvement in $(R)^2$	Accumulative$(R)^2$
X_o	.0844816	----	----
X_{11}	.0978815	.918012	.918012
X_1	-19.0927	.055508	.97352
X_8	-.213871	.017697	.991217
X_6	-.605184	.008754	.999971

Residual Mean Squared - .0000479332
Standard Error of Y - .00692338

This equation is an abnormally close fit for the number of data sets analyzed. Standard error of Y is very low as is the Residual Mean Square. Table 7 indicates that 100 percent of variation in elk use in this Timber Habitat Type is explained. This is difficult to believe with the small sample size involved. There is no doubt, however, that variables X_{11}, X_1, X_8 and X_6 are extremely important in describing elk use areas in Type 292.

Variable X_{11} (Temperature X moisture of nearest adjoining habitat type from Figure 1) must be considered as most important of the four variables listed. This variable accounts for .918 of the variation in elk use. Reference to Table 4 shows this as a positive correlation, indicating that elk using Habitat Type 292 tend to concentrate in areas where the nearest adjoining Habitat Type is cool and moist. The second variable entering is X_1 $(\frac{1}{\text{Slope}})$. This relationship is positive in Table 4 indicating that shallower slopes are preferred at the higher pellet group densities. This relationship is obvious when considering the shallow slopes in conjunction with cool, moist environments. Variable X_8 (distance to the nearest adjoining Habitat Type) is the third variable to enter. The value from Table 4 is negative indicating higher pellet densities at smaller distances from the moist-cool nearest Habitat Type.

The final variable, X_6, (Screening index of tree stems)^2 also negative from Table 4 for indicating a preference for more open timber stands.

Table 8 - Regression summary for Timber Habitat Type 323
Psme/Caru/Caru
Number of Data Sets: 27

None of the variables satisfied the F for inclusion in the regression.

No correlations were found in either the regression analysis or from the correlation Matrix in Table 4.

Four possible situations could explain the lack of correlation within Habitat Type 323:

1. Very low variation in elk pellet group densities within the type.
2. Very low variation in environmental factors within the type.
3. Variables chosen were not adequate to explain the variation in elk use and the environmental factors which existed.
4. Elk pellet group indices were uniform throughout the Type regardless of variation in environmental factors.

In view of the variables chosen, which pertain to cover requirements, topography, moisture, temperature and vegetation, it is not plausible that some variation in elk use and environment would not be accounted for if variation existed. For this reason, possibility 3 is discarded.

Elk pellet group density indices were scattered well over a range of .01-1.60 within the Habitat Type. Possibility two must be discounted on that basis.

Either of the two remaining possibilities indicate that this Habitat Type is uniformly used by elk at a high level, and that the entire Habitat Type must be treated as important elk habitat.

Table 9 - Regression Summary for Timber Habitat Type 650
Abla/Caca
Number of Data Sets: 10

Variables	Beta Coefficients	Improvements in $(R)^2$	Accumulative$(R)^2$
X_o	-.827945	----	---
X_1	.928034	.415159	.415159
X_{10}	.22265	.079398	.494557
X_3	-.609465	.109661	.604218

Residual Mean Squared - .0859624
Standard Error of Y - .293194

Table 9 indicates a good fit with only 3 environmental variables intered into the equation. The low residual mean square and acceptable standard error of Y, coupled with an R^2 of .6042 is about as good as can be normally expected in this type of an analysis.

preferred Habitat Types. Much of the type may be used for cover in relation to tall shrubs species which are primarily Menzieia and Alder. These species have affinity for the cool-moist types described in the regression and are also found on slopes of all exposures, except south, where they are never present in high quantities.

Table 11. Regression Summary for Timber Habitat Type 662
Abla/Libo/Xete
Number of Data Sets: 46

Variables	Beta Coefficients	Improvement in $(R)^2$	Accumulative $(R)^2$
X_o	-1.62146	-----	------
X_1	25.4368	.244729	.242729
X_{11}	-.0415594	.076781	.31951
X_5	-23.5971	.041304	.360814
X_3	1.112361	.053298	.414112
X_4	.940418	.033026	.447138
X_2	-.00106029	.043848	.490986
X_9	.273493	.017118	.508104
X_{10}	.132142	.023878	.531982

Residual Mean Squared - .110571
Standard Error of Y - .332523

In Timber Habitat Type 662, R^2 is reasonably good. The Residual Mean Square is low enough to imply an acceptable fit. The standard error, although higher than the desirable, is not too high in relation to R^2 to assure some credibility to the equation.

Although 8 variable appear, the equation uses only $\frac{1}{\text{slope}}$, temperature of the adjoining type, moisture of the adjoining type, screening index, canopy cover, and aspect as key variables or 6 different variables + 2 interactions.

From Table 4, the positive correlation with X_1 indicates a preference for shallow slopes in this Habitat Type. The positive correlation with X_9, X_{10}, and X_{11} indicates preference for areas near cool-moist adjoining types. A negative correlation with X_2 indicates a tendency toward southerly slopes. X_3 indicates a preference for more open timber areas. Variable X_5 entering the equation is positive in value and indicates a stronger tolerance for denser tree stems where slopes are flat. This qualifies the apparent preference for open timber areas. Variable X_4 (canopy cover) is also positive in Table 4 indicating preference for higher canopy covers.

There is slight paradox in the results of this analysis, in that flat, denser timbered slopes, close to cool-moist environment, appears to be important. On the other hand, open, southerly slopes are also important. Elk use in this Habitat Type appears to be more complex than that of other types in Chamberlain Creek.

Variable X_1 ($\frac{1}{\text{slope}}$) is the first variable entering and must be considered most important in predicting elk use in this type. This variable is a relatively high positive value from Table 4, indicating a preference for shallow slopes. Variable X_{10} (moisture of adjoining type) is the second variable entering and is also positive showing an affinity for more moist environments.

Variable X_3 (screening index of tree stems) is a negative value in Table 4, indicating a preference for slightly more open timber stands in Habitat Type 650.

Table 10 - Regression Summary for Timber Habitat Type 670
Abla/Mefe
Number of Data Sets: 82

Variables	Beta Coefficients	Improvement in $(R)^2$	Accumulative $(R)^2$
X_o	-8.26218	---	---
X_9	1.41263	.154348	.154348
X_{11}	-0.121202	.107839	.262187
X_{10}	.660164	.041945	.311332
X_6	-2.08147	.032402	.343734
X_3	1.91949	.035095	.378829
X_2	.000636846	.009508	.38837

Residual Mean Squared - .171948
Standard Error of Y - .414666

Timber Habitat Type 670 is a moist type with relatively high amounts of cover in the wetter parts. From Table 10 it is seen that temperature of adjoining type - X_9, a multiplicative combination of temperature and moisture in adjoining type - X_{11}, and moisture of the nearest adjacent type have much to do with elk use of these sites.

Variables X_6 and X_3 relate to screening index of tree stems and variable X_2 relates to aspect as a deviation from south.

Values of X_9, X_{10}, and X_{11} are positive from Table 4, indicating a preference for Habitat Type 670, where the nearest adjoining type is cool and moist.

Variables X_3 and X_6 are both negative in Table 4, indicating a slight preference for more open timber, and X_2 is positive indicating preference for aspects other than south. An additional variable expressing aspect as a deviation from west was inadvertantly left out of the equation. This variable would have done much to tie down the favored aspect in this case.

Although R^2 is not exceptionally high in this case, and the Residual Mean Squared is high enough to imply a less than desirable fit, coupled with relatively high standard error of the dependent variable, it is felt that the R^2 of .3883 does explain some of the variation in this Habitat Type. It appears that elk prefer cool-moist areas with less than average tree stem screening on exposures other than south. This is not one of the more

Table 12 - Regression Summmary for Habitat Type 691
Abla/Xete/Vagl
Number of data sets: 149

Variables	Beta Coefficients	Improvement in $(R)^2$	Accumulative $(R)^2$
X_o	.67363	----	----
X_1	.717668	.0282513	.0282513
X_9	.0298154	.0138134	.0420647

Residual Mean Squared - .119732
Standard Error of Y - .346023

In this Habitat Type very little variation was explained. The type is only moderately used by elk and is the largest Habitat Type in Chamberlain Creek. Very little vegetative differences appear in Table 2 between areas of zero pellets and areas where pellets were found.

No strong correlations appear in Table 4, which would indicate any preferences within the Habitat Type. The only statement which can be made is that Habitat Type 691 appears to be uniformly used at a moderate level with only slight preferences for more shallow slopes adjacent to cooler environments.

Table 13-Regression Summary for Habitat Type 692
Abla/Xete/Vase
Number of Data Sets: 21

Variables	Beta Coeffiecients	Improvement in $(R)^2$	Accumulative $(R)^2$
X_o	.227221	----	----
X_5	.957719	.132149	.132149
X_{10}	.140637	.089452	.221601
X_9	.151062	.06866	.290261
X_8	.0459558	.082098	.372359

Residual Mean Squared - .0230104
Standard Error of Y - .151712

This is the least preferred Habitat Type in the study area only. The ratio of availability to use is 5:1.

Variables in the above equation, except X_8, fully support this low preference rating. Variable X_5 $(\frac{\text{screen}}{\text{slope}})$ is positive from table for indicating preference for shallow slopes with high screening index. This, coupled with affinity for X_{10} (moisture of adjoining type) which is positive, and a positive trend toward use with cool adjoining types, indicates that this type is used more where cover is relatively high on more shallow slopes near cool or moist environments.

Variable X_8 is positive from Table 4, indicating a preference for Type 692 further from adjoining Habitat Types. This appears to be a paradox in relation to affinity for cool-moist adjoining types.

Considering the fact that Type 692 is in a moderate position on the temperature-moisture scale (figure 1), and is located predominantly above midslope, dryer adjoining Habitat Types out number the moist types 15 to 3. Affinity for 3 cool-moist sites and aversion to 15 dryer sites would give the positive value of X_8. The only cool-moist environment (from Table 5) found near Type 692 is Type 650, Abla/Caca. Additional cool-moist sites may include Abla/Clun, Abla/ Gatr, or Abla/Mefe Habitat Types, which had insufficient samples taken individually, but would show up in the regression when taken together. In view of the above discussion, the apparent paradox created by Variable X_8 may not be real, and may only express a skewed distribution of the variable.

Table 14. Regression Summary for Timber Habitat Type 780

Abla/Arco

Number of Data Sets - 9

None of the variable correlated strongly enough to satisfy F for inclusion.

Although these areas were among the highest used sites in Chamberlain Creek, they were considered by Pfister (figure 1) to be only incidental areas of small size within other habitat types. Only 12 total plots were of this type in the study area. 75 percent of these plots were used by elk. The plots were characterized by about 77 percent Arnica cordifolia with no other species exceeding 4 percent of the composition. The apparent small size of these types would negate the probability that high variation existed and correlation would be expected to be nominal.

Table 15 - Summary of elk preferences in Chamberlain Creek from vegetative summaries, Habitat Type Preference Ratings and Regression Summaries.

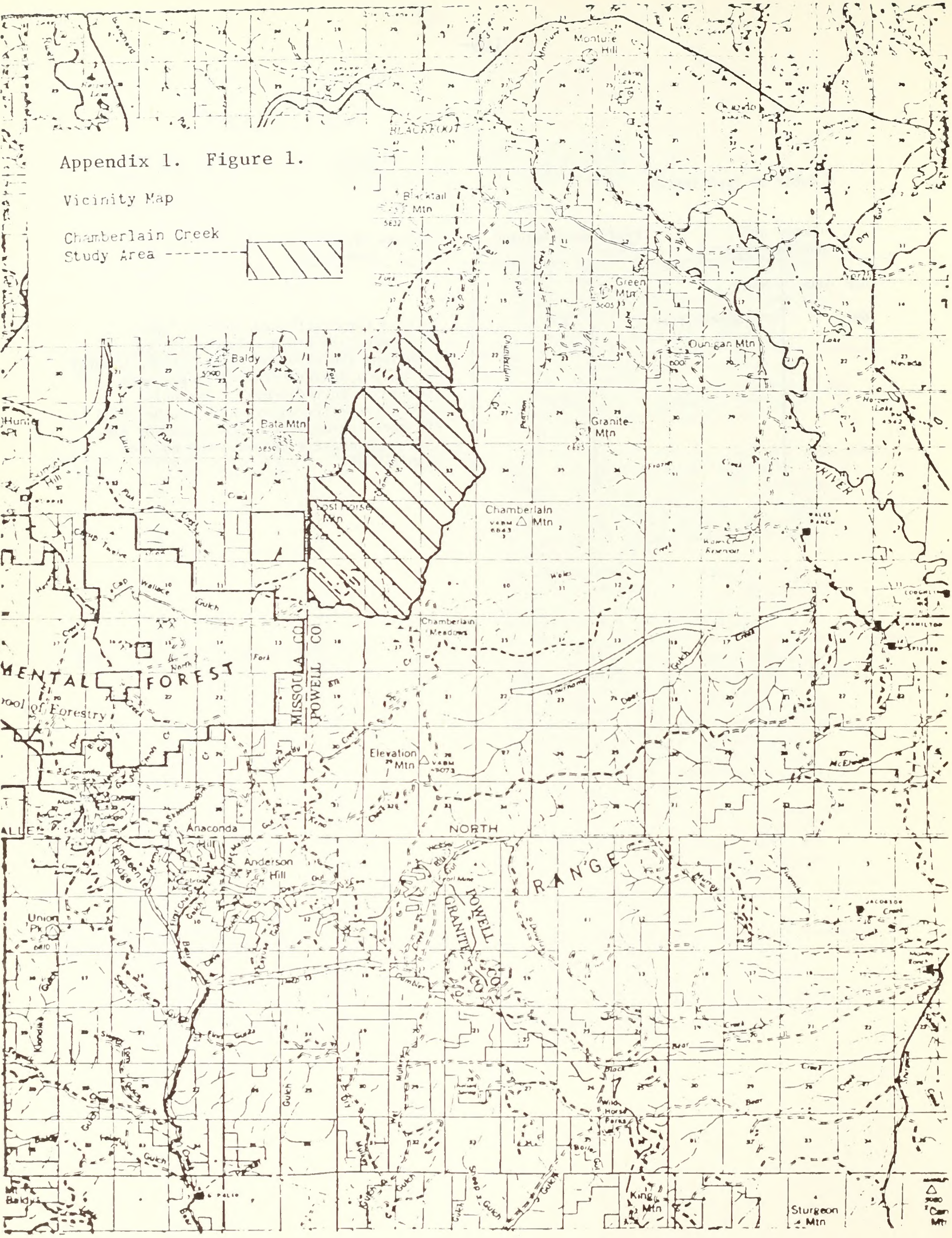
Timber and Habitat Type		Preference Rating	Factors relating to elk Preference
ADP Code	Name		
*330	Psme/Cage	2.99	None-use areas contain 35 percent Arco 17.6% Aclafed 1% Cage. Areas used by elk contain only 1.4% Arco and only 5.7% Acla, but contain 40% Cage.
*321	Psme/Caru/Agsp	2.62	High preference. No correlations can be found for description of factors.
*632	Abla/Gatr/Caca	2.62	Factors relating to preference are probably the same as those described for H. T. 650 Abla/Caca
323	Psme/Caru/Caru	1.59	Key vegetation appears to be Bere, Cage, found in greater quantities in higher use areas. No regression correlations were derived. Entire Habitat Type appears to be important to elk with little variation in use in relation to environmental variables.
780	Abla/Arco	1.40	This type appear only 12 times in the data. R. Pfister (Figure 1) feels that it is only small areas incidental to other types. The only factor identified is the high (77%) amount of Arco is the composition. No regression correlations derived.
271	Psme/Xete/Vagl	1.36	Regression correlations indicate that preference is related to southerly, steeper slopes with relatively open stands of timber.
650	Abla/Caca	1.26	Regression correlations indicate preference for moist environments on more open timbered shallow slopes. This type comprises the wet meadows, etc.often used for bedding areas.
*281	Psme/Vagl/Vagl	1.16	Higher quantities of Arco in high use areas and lower amounts of Libo and Vagl suggest that elk prefer the dryer portions of this habitat type.

Table 15(continued)

Timber and Habitat Type ADP Code	 Name	Preference Rating	Factors relating to elk Preference
670	Abla/Mefe	.94	This is a moderately used type. Regression correlations indicate preference for cool-moist environments with fewer timber stems on other than southerly slopes. Vegetative character indicates that higher quantities of Menziesia are present in preferred areas.
691	Abla/Xete/Vagl	.94	This type is moderately used by elk. Slight preference with cool-shallow slope environments is indicated. No strong preference appear to be present in this type.
662	Abla/Libo/Xete	.93	This is a moderately use type with a rather complex pattern of elk preferences as determined by regression. It appears that shallow, slightly more open slopes in cool-moist environments are favored by elk in this type. The only vegetative differences are noticable increases in Arco and Xete in areas of elk use. This vegetative difference may not be meaningful.
292	Psme/Libo/Caru	.92	This is a moderately preferred Habitat Type, with strong regression correlation indicating preference for shallow, open timbered slopes close to cool-moist environments. Sharp increases in Bere Pteridium occur on preferred sights, indicating very moist-cool conditions. Pyrola also shows significant increases in areas used by elk.
*720	Abla/Vagl	.68	This is a relatively low use type with only 20 occurances drainage wide. Of these, 13 received no elk use. Greater amounts of Forbs such as Pyrola and Arnica and a greater amount of Vasc occurs on preferred sites.
*661	Abla/Libo/Libo	.37	A low use area for elk. The only difference between used and non-used areas in this type is the apparent greater number of forbes, which associate with moist areas, such as Galium, Pyrola, Trillium Veratrum, and Viola.

Table 15 (Continued)

Timber and Habitat Type		Preference Rating	Factors relation to elk Preference
ADP Code	Name		
692	Abla/Xete/Vasc	.21	This is the least used Habitat Type in Chamberlain Creek. Regression correlations indicate that use is made; however, on shallow denser timbered slopes near cool-moist environments. The only vegetative differences which can be found is 50% more Arnica in the areas used by elk. This vegetative difference may not be significant.

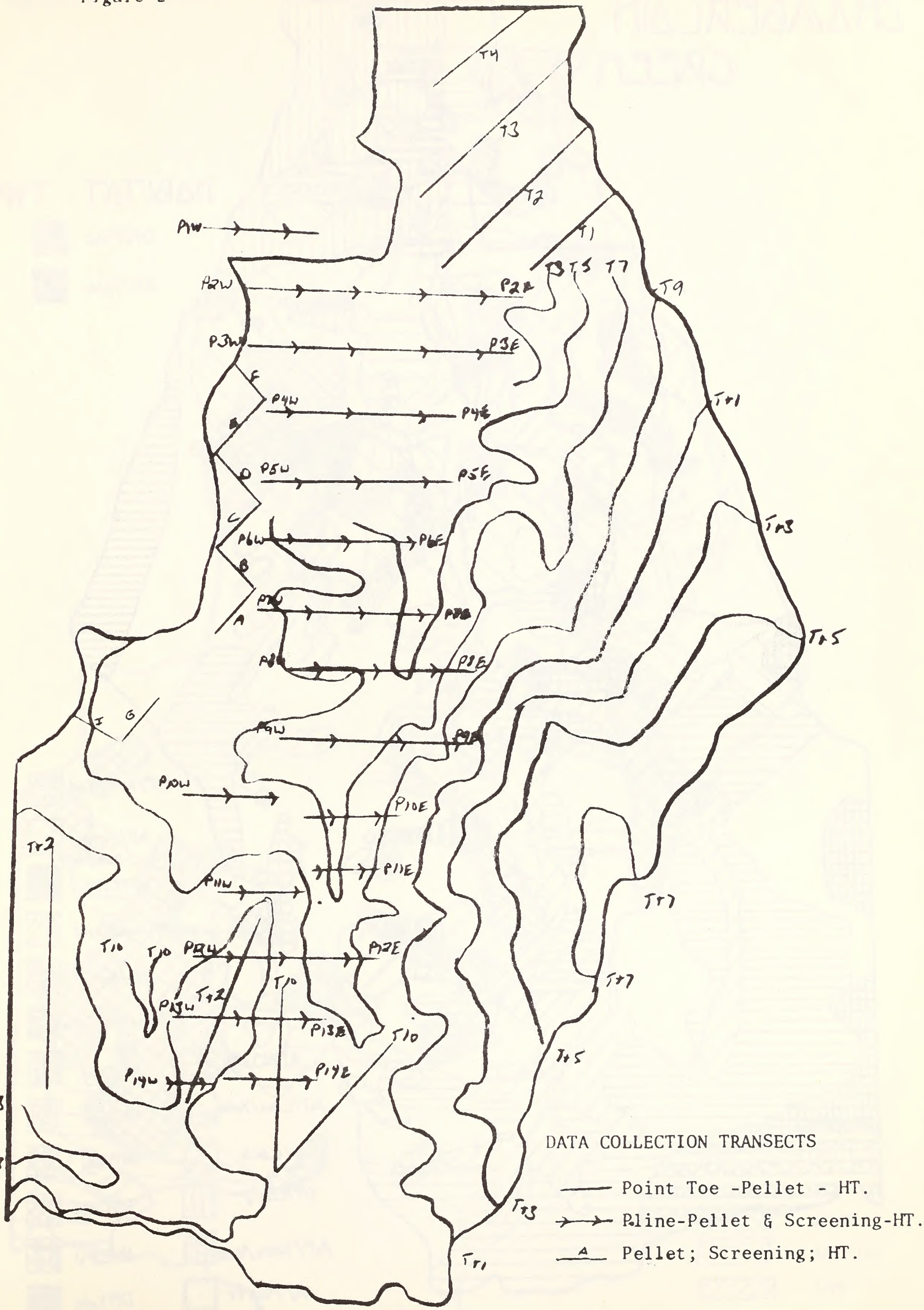


Appendix 1. Figure 1.

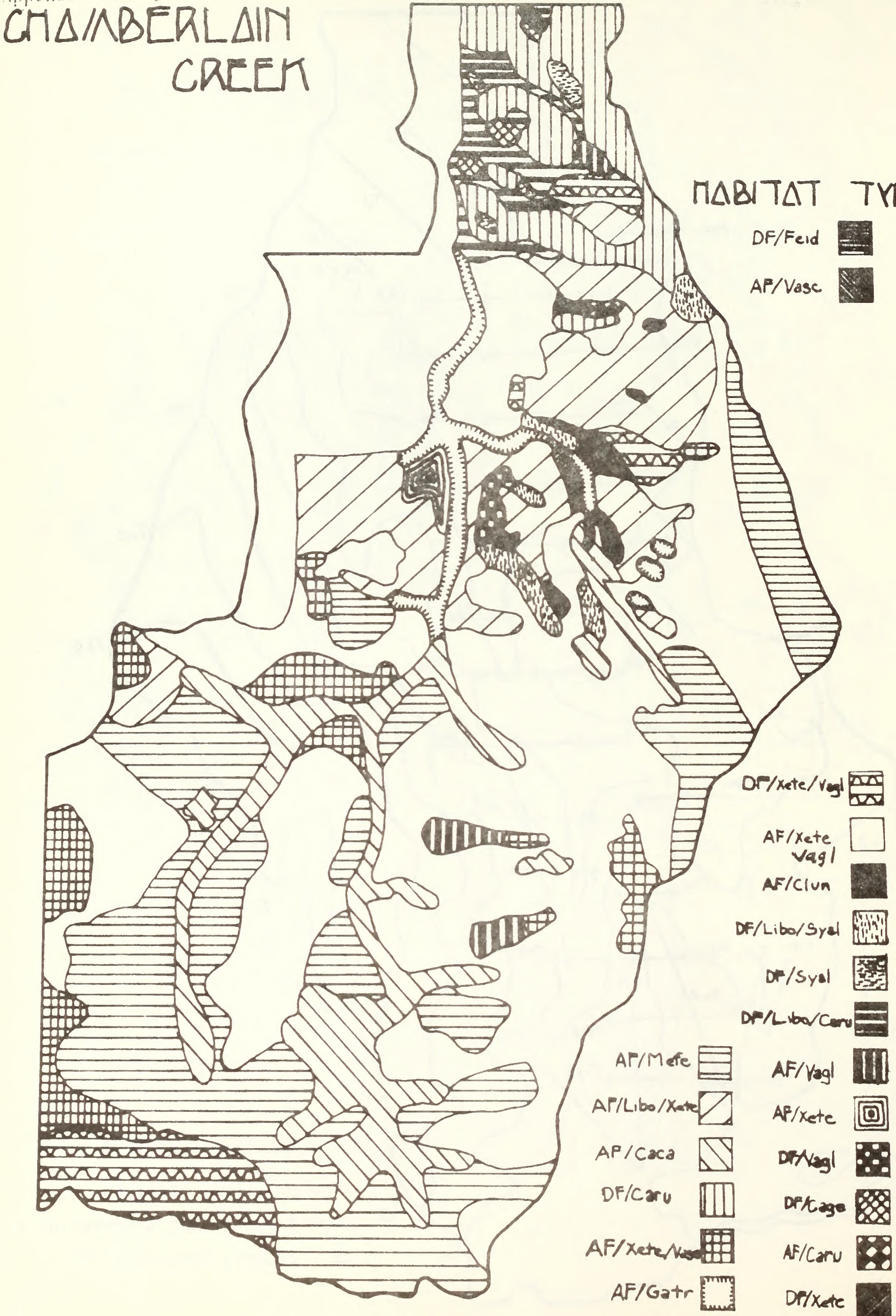
Vicinity Map

Chamberlain Creek
Study Area
Montuie Hill
Ovando
BLACKFOOT
Blacktail Mtn
5832
Green Mtn
5605
Dunigan Mtn
Baldy
Bata Mtn
5850
Granite Mtn
Lost Horse Mtn
Chamberlain Mtn
6643
Chamberlain Meadows
Camp Twelve
Cap Wallace Gulch
MENTAL FOREST
School of Forestry
MISSOULA CO
POWELL CO
Elevation Mtn
7073
Anaconda Hill
Anderson Hill
NORTH
RANGE
POWELL
GRANITE CO
Union Pk
6810
Wild Horse
King Mtn
Sturgeon Mtn
Baldy
RIVER

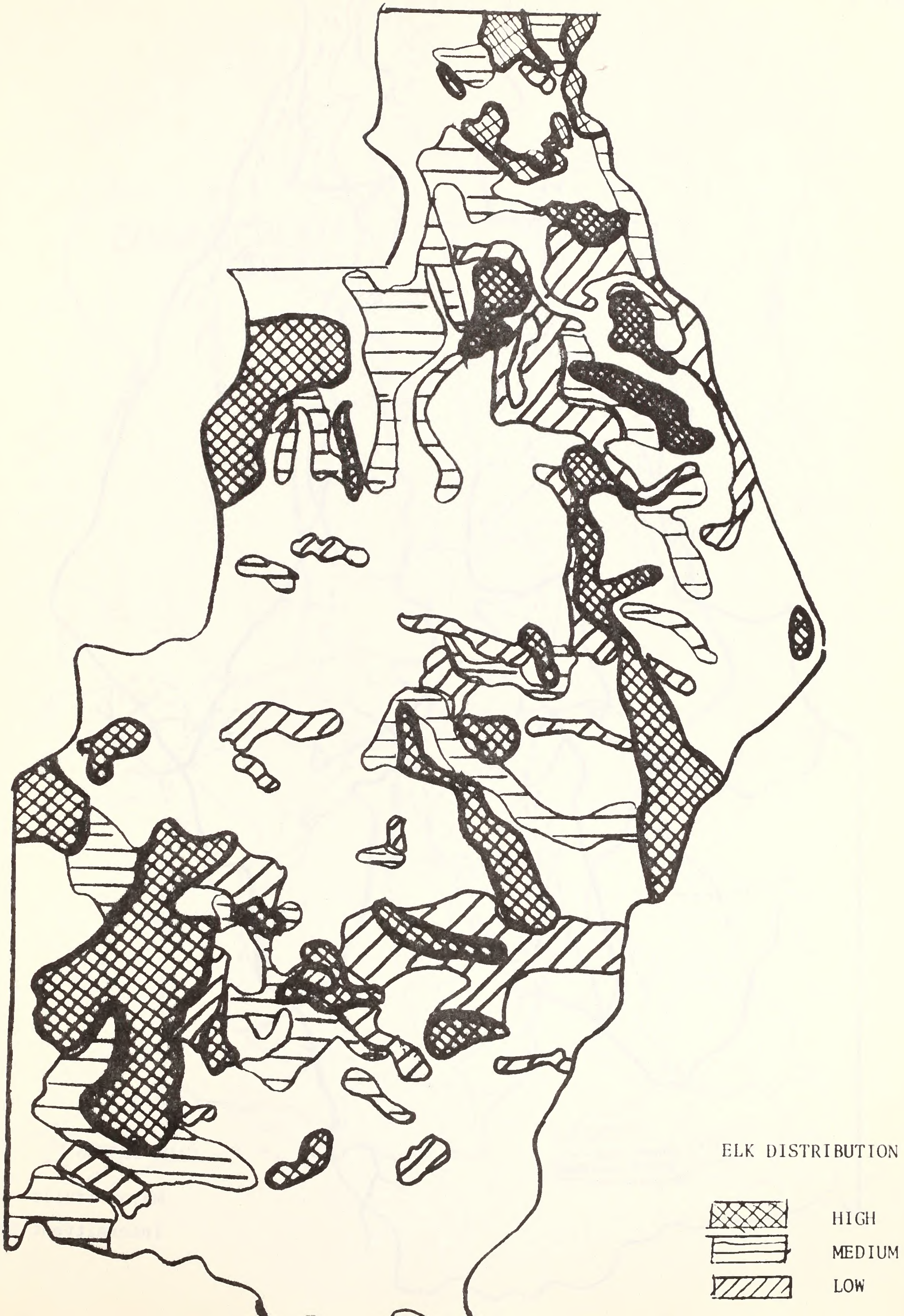
Appendix 1
Figure 2


T4
T3
T2
T1
P1W
P2W
P2E
P3W
P3E
P4W
P4E
P5W
P5E
P6W
P6E
P7W
P7E
P8W
P8E
P9W
P9E
P10W
P10E
P11W
P11E
P12W
P12E
P13W
P13E
P14W
P14E
T3
T5
T7
T9
Tr1
Tr3
Tr5
Tr7
T10
Tr2
A
B
C
D
E
F
G
I
DATA COLLECTION TRANSECTS
Point Toe -Pellet - HT.
Pline-Pellet & Screening-HT.
Pellet; Screening; HT.

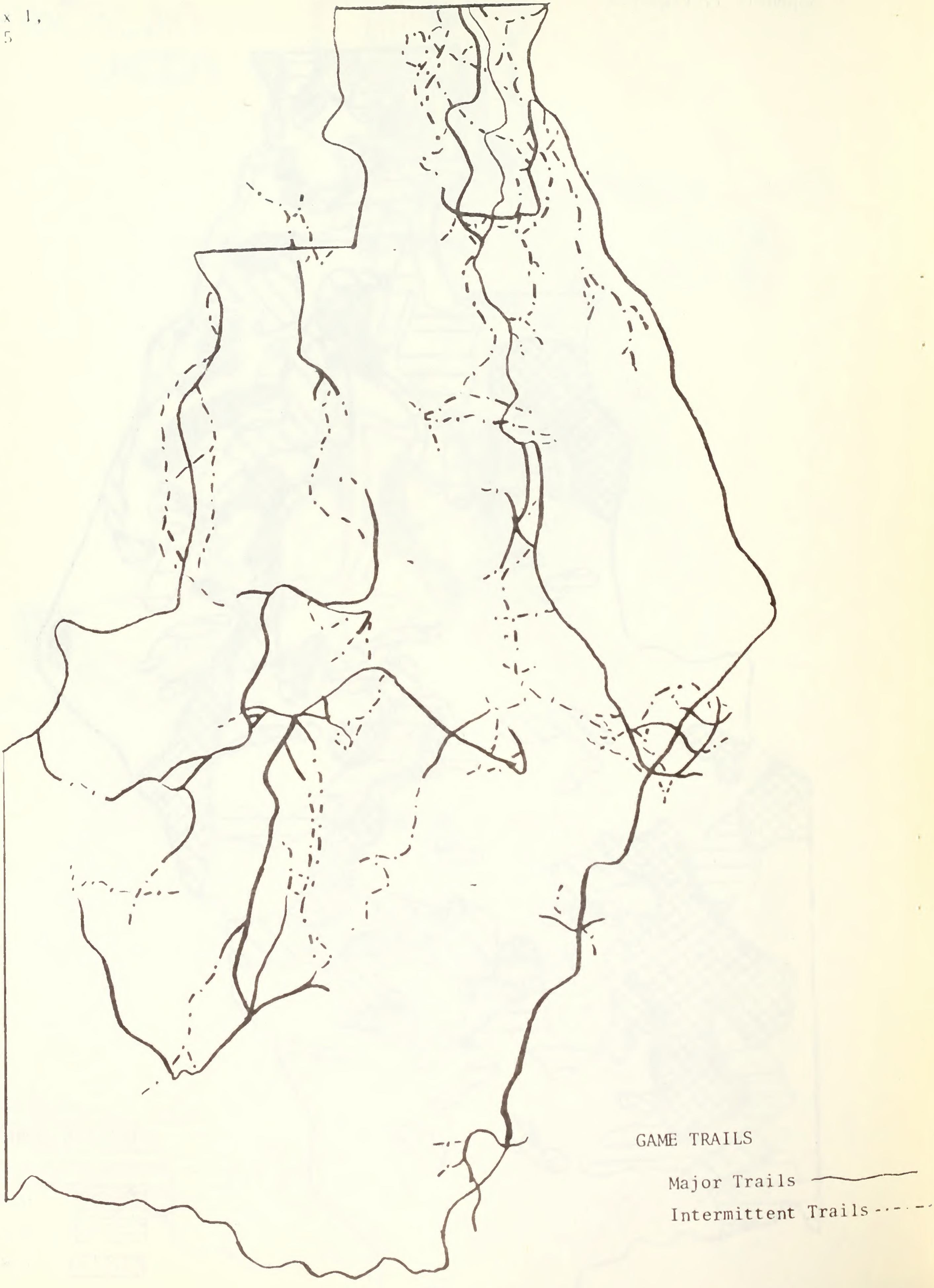
Appendix 1, Figure 5


CHAMBERLAIN CREEK
HABITAT TYPES
DF/Feid
AF/Vasc
DF/xete/Vagl
AF/Xete Vagl
AF/Clun
DF/Libo/Syal
DF/Syal
DF/Libo/Caru
AF/Vagl
AF/Xete
DF/Vagl
DF/Cage
AF/Caru
DF/Xete
AF/Mefe
AF/Libo/Xete
AF/Caca
DF/Caru
AF/Xete/Vasc
AF/Gatr

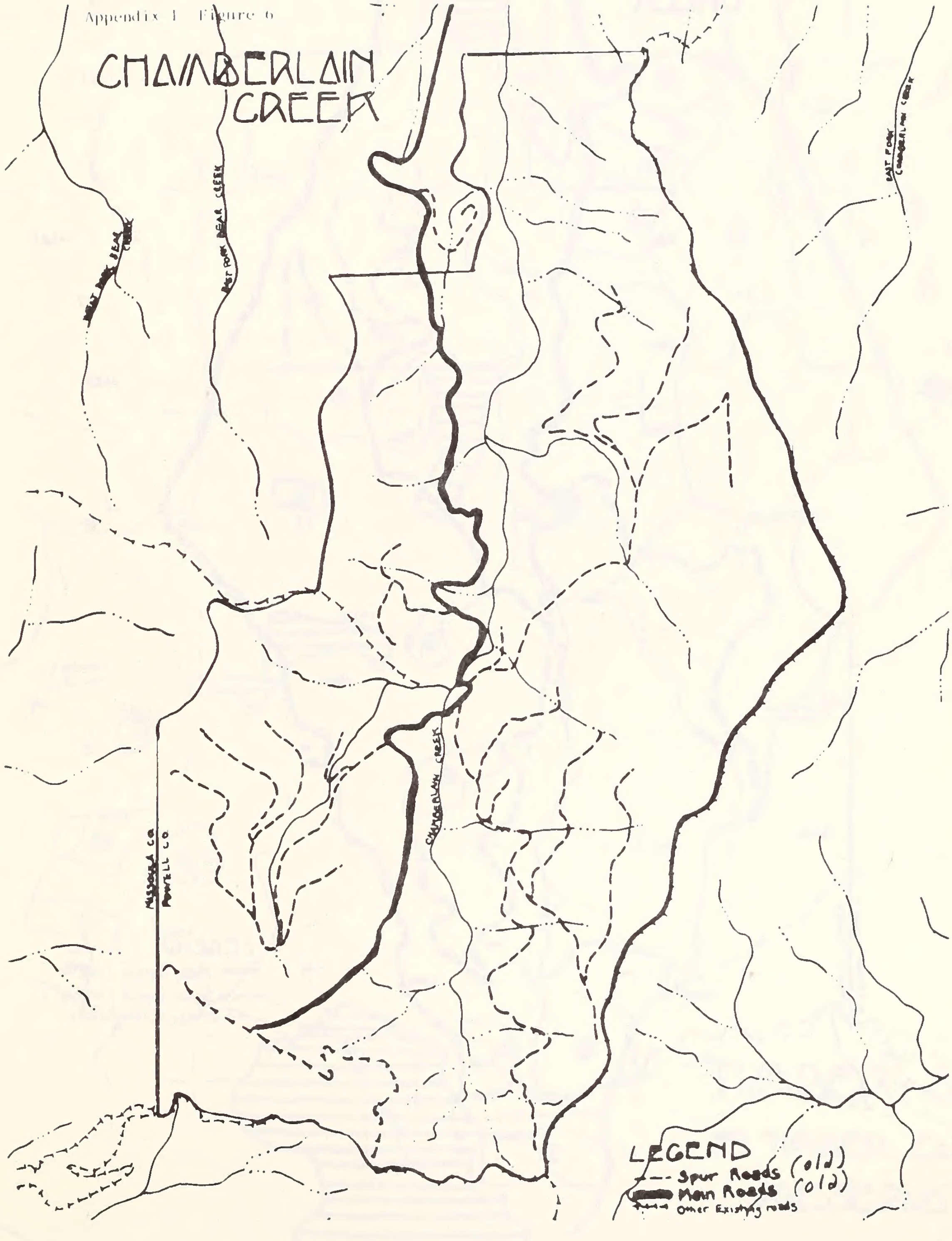
Appendix 1, Figure 4


ELK DISTRIBUTION
HIGH
MEDIUM
LOW

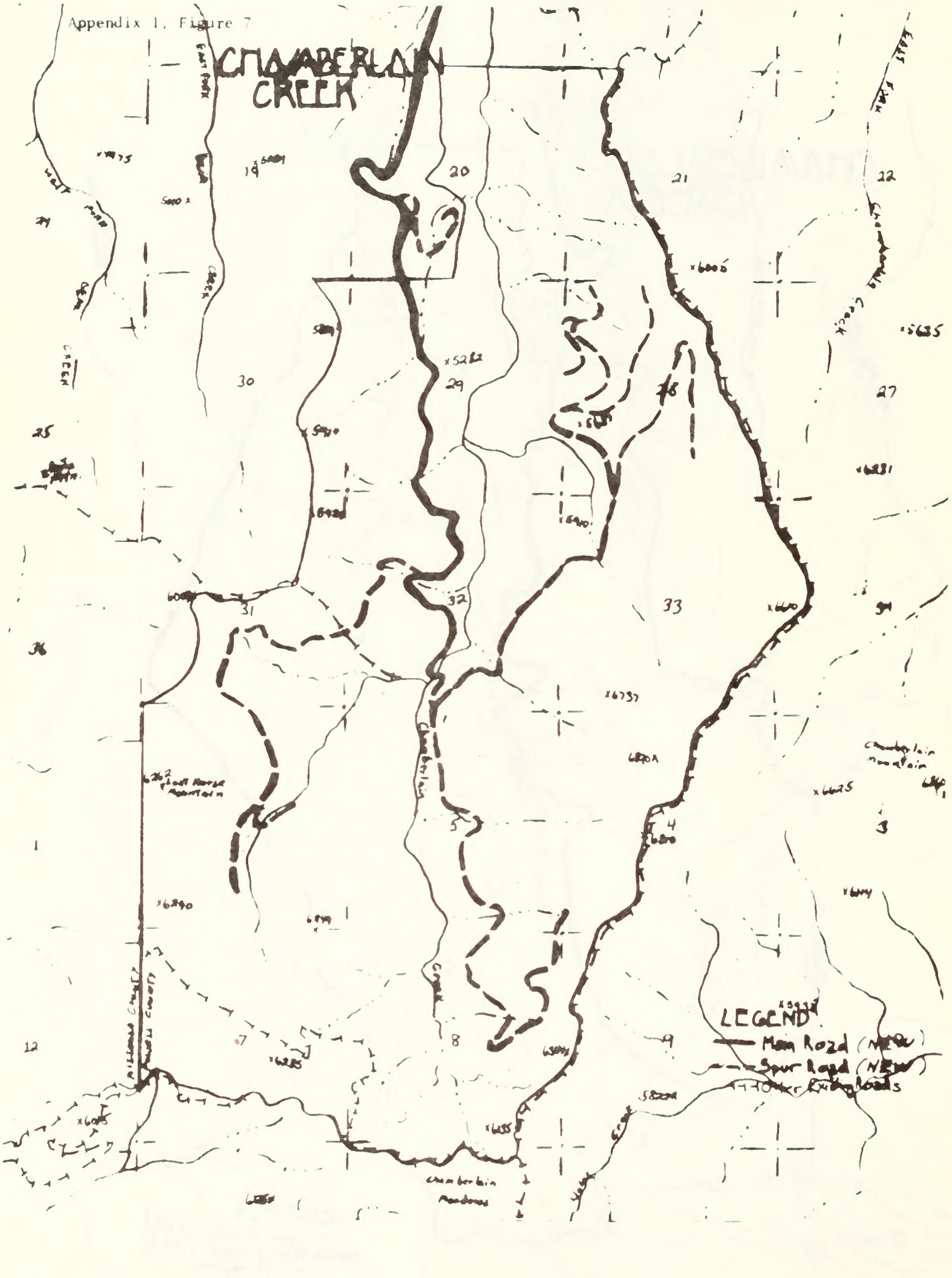
Appendix 1,
Figure 5


GAME TRAILS
Major Trails
Intermittent Trails

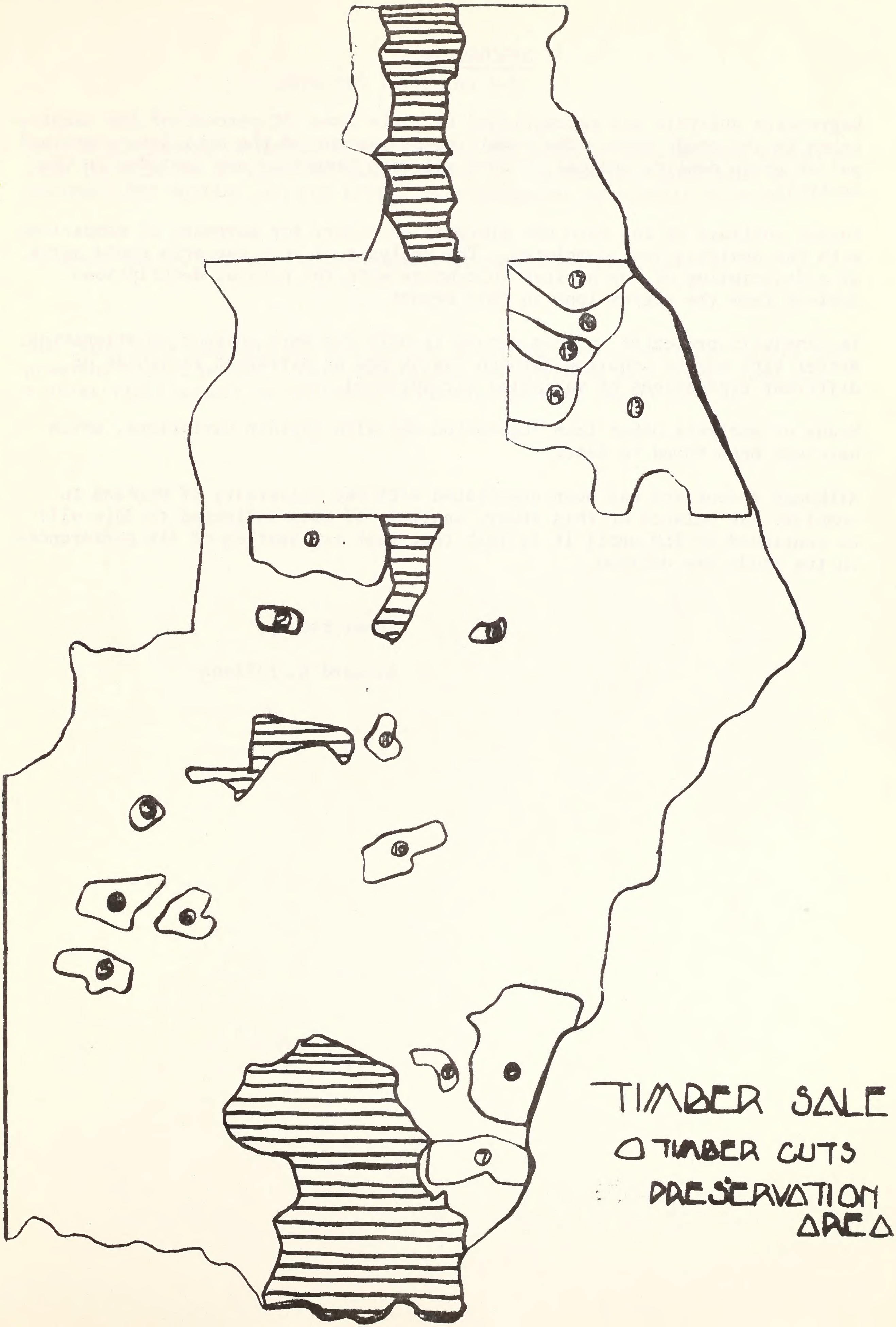
Appendix I Figure 6


CHAMBERLAIN CREEK
BEAR CREEK
EAST FORK BEAR CREEK
EAST FORK CHAMBERLAIN CREEK
CHAMBERLAIN CREEK
MISSOULA CO.
POWELL CO.
LEGEND
Spur Roads (old)
Main Roads (old)
Other Existing roads

Appendix 1, Figure 7


CHAMBERLAIN CREEK
East Fork
West Fork
Creek
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
1
3
4
5
7
8
9
12
x5282
x6006
x5635
x6281
x6737
x6625
Chamberlain Mountain
Lost Horse Mountain
x6240
Chamberlain Creek
x6285
x6455
Chamberlain Meadows
LEGEND
Main Road (NEW)
Spur Road (NEW)
Other Existing Roads

Appendix 1, Figure 8


17
16
15
14
13
7
TIMBER SALE
○ TIMBER CUTS
PRESERVATION AREA

DISCUSSION

Regression analysis was accomplished for only about 50 percent of the samples taken in the study area. The remaining 50 percent of the data sets contained pellet group density indices of zero and were therefore not included in the analysis.

Future analysis of the zero use plots is necessary for purposes of comparison with the analysis just completed. The analysis of zero use area would serve as a description of Non-habitat to compare with the habitat descriptions derived from the regressions in this report.

The analysis presented in this report is only the more obvious relationships. Better fits may be acquired through use of new or different variables or different expressions of variables already used.

Means of analysis other than regression may also explain variations, which have not been found to date.

Although a contract has been negotiated with the University of Montana to complete the balance of this study, analysis of data collected to date will be continued by BLM until it is felt that best explanation of elk preferences in the study are derived.

Submitted by:

Richard L. Ellison

JOBS III - A-1 AND A-2

DETERMINE CHANGES IN HUNTER DISTRIBUTION, ELK BEHAVIOR AND HARVEST RESULTING FROM THE CLOSURE OF EXISTING ROAD SYSTEMS IN THE GRAVELLY MOUNTAINS OF SOUTHWESTERN MONTANA AND THE LITTLE BELT MOUNTAINS OF CENTRAL MONTANA.

Progress Report for the Period January 1 - December 31, 1974.

All field work and data collection for these jobs were completed during the previous report period. Data tabulation and analyses have progressed and a joint final report is anticipated during the next report period.

[illegible]

JOBS 112 - A-1 AND A-2

DIFFERENTIAL CHANGES IN HUNTER DISTRIBUTION, ELK DISTRIBUTION AND HARVEST RESULTING FROM THE CLOSURE OF EXISTING ROAD SYSTEMS IN THE GRAVELLY MOUNTAINS OF SOUTHWESTERN MONTANA AND THE LITTLE BELT MOUNTAINS OF CENTRAL MONTANA.

Progress Report for the Period January 1 - December 31, 1973

All field work and data collection for these jobs was completed during the previous report period. Data analysis and [illegible] are being completed and a joint final report is anticipated during the next report period.

JOB III - B

ELK USE OF DISTURBED AREAS

INTRODUCTION

The 1974 report on this study described the sampling method[1] and some initial analyses of elk pellet distributions in and around clearcuts. None of the analyses presented were considered particularly satisfactory, and about the only positive conclusion presented was that interactions among independent variables were confounding and obscuring any useful information in the data.

The relative mean square residual screening analysis presented in 1974 had an $R^2 = .749$ for predicting elk pellets inside clearcuts and an $R^2 = .805$ for predicting deer pellets. However, in both analyses, the three most powerful independent variables were (1) other pellets inside the cut and (2)(3) elk and deer pellets outside the cut. Obviously, the revelation that pellet groups are a function of big game populations is not particularly useful.

During 1974, no further fieldwork was conducted, but a new analysis was completed by Chester E. Jensen, Mathematical Statistician, Intermountain Forest and Range Experiment Station, Ogden. The results of this analysis were startling on both statistical and biological grounds. From an analytic standpoint, it is possible to demonstrate a procedure which accounts for interaction effects and, in this case, produces valuable information from data which had every appearance of being hopeless. From a biological standpoint, the analysis revealed some unexpected relationships between big game and their habitat and did so in a way which can be directly translated to management action.

METHODS

For readers interested in a more complete description of the analytic technique used, the three publications in the Matchacurve series (Jensen and Homeyer, 1970 and 1971; Jensen, 1973) are recommended. Basically, the method involves subjective transformation of the graphed data into an algebraic model. Because the approach is subjective, the analyst has an opportunity to interject both biological expectation and some personal judgment into the selection of variables. At the same time, as the following brief summary will demonstrate, a certain amount of seredipity may be of considerable assistance.

---

[1] The instructions for sampling were inadvertently omitted from the 1974 progress report. They are included as an appendix to this report.

The original regression screen applied to pellet data involved eleven variables:

Inside the opening

1. mean elk pellets
2. mean deer pellets
3. mean vegetation height
4. mean slash depth

Outside the opening

5. mean elk pellets
6. mean deer pellets
7. mean cover quality
8. mean dead and down depth

Size of opening

9. perimeter
10. acres
11. perimeter^2/acres

Whether elk pellets (1) or deer pellets (2) was treated as the independent variable, the largest possible multiple regression analysis involved 10 independent variables. In both cases, the three independent pellet variables proved to be powerful linear predictors, but the information provided had no usable relationship to clearcuts, slash, or other factors that can be controlled by the land manager. Thus, the first subjective, but logical, decision was to eliminate these variables from consideration.

Of the seven remaining variables, four are descriptive of habitat conditions in and around clearcuts and three are descriptive of clearcut size and shape. All seven variables, or any combination, might have been included in the model, but since the modelling technique is based on hand-fitting of plotted data, the logistics of data handling require some reduction in the number of variables examined. Moreover, since these data include only 49 observation sets, the analysis has some obvious restrictions related to fitting curves on a limited number of data points. Thus, the second subjective decision involved choosing a smaller set of independent variables for analysis, or, as an alternative, examining different combinations until the best fit is obtained.

In this case, it was relatively easy to reduce the choice to five independent variables. The three size and shape variables were all negatively correlated with pellet groups and positively correlated with each other. Of the three, however, acres (10) was selected as the most widely understood and commonly used in land management.

Among the four habitat variables, slash inside (4) had the strongest linear correlation with elk pellets (1) ($r = -.339$); and dead and down outside (8) had the strongest correlation with deer pellets (2) ($r = -.364$). However, there is no obvious reason to accept linearity, and in these data none of the linear correlation coefficients were sufficiently large to justify mandatory inclusion in the model. Of the four, however, vegetation inside (3) and slash inside (4) seemed to be logical first selections; slash because there must be some depth at which movement by animals is inhibited and vegetation because a requirement for forage and cover are logical assumptions if animals are to use the openings.

On the basis of these considerations, three variables were tested in the initial model: slash inside (4), vegetation inside (3) and acres (10). Later, because of the initial fit proved to be so good, it was possible to add a fourth variable, dead and down outside (8) to the final model.

RESULTS

Output for this analysis can be presented as a series of graphic displays or as an algebraic equation describing the curve shapes and interactions predicting pellet groups. However, the algebraic expressions are extremely complicated, and in the interest of brevity are not presented in this report.

The equation for deer pellets provides an extremely good fit to the available data. Linear R^2 with four variables is only 0.21, but R^2 for the model is 0.71. For elk, the improvement was not as great, but the four variable model produced $R^2 = .40$ compared to 0.25 for the linear regression.

Interpretation of the model can best be understood by examining, first a single submodel (fig. 1) for which vegetation height is three feet and down timber depth is 0.5 feet. Within these constraints, the submodel presents a prediction surface on which slash depth and acres are used to estimate the number of pellet groups inside the clearcut. For example, a clearcut of 60 a. with slash 0.5 feet deep would be expected to have about 200 deer pellet groups per acre. The same clearcut with 2.0 feet of slash would be expected to have only 90 pellet groups per acre.

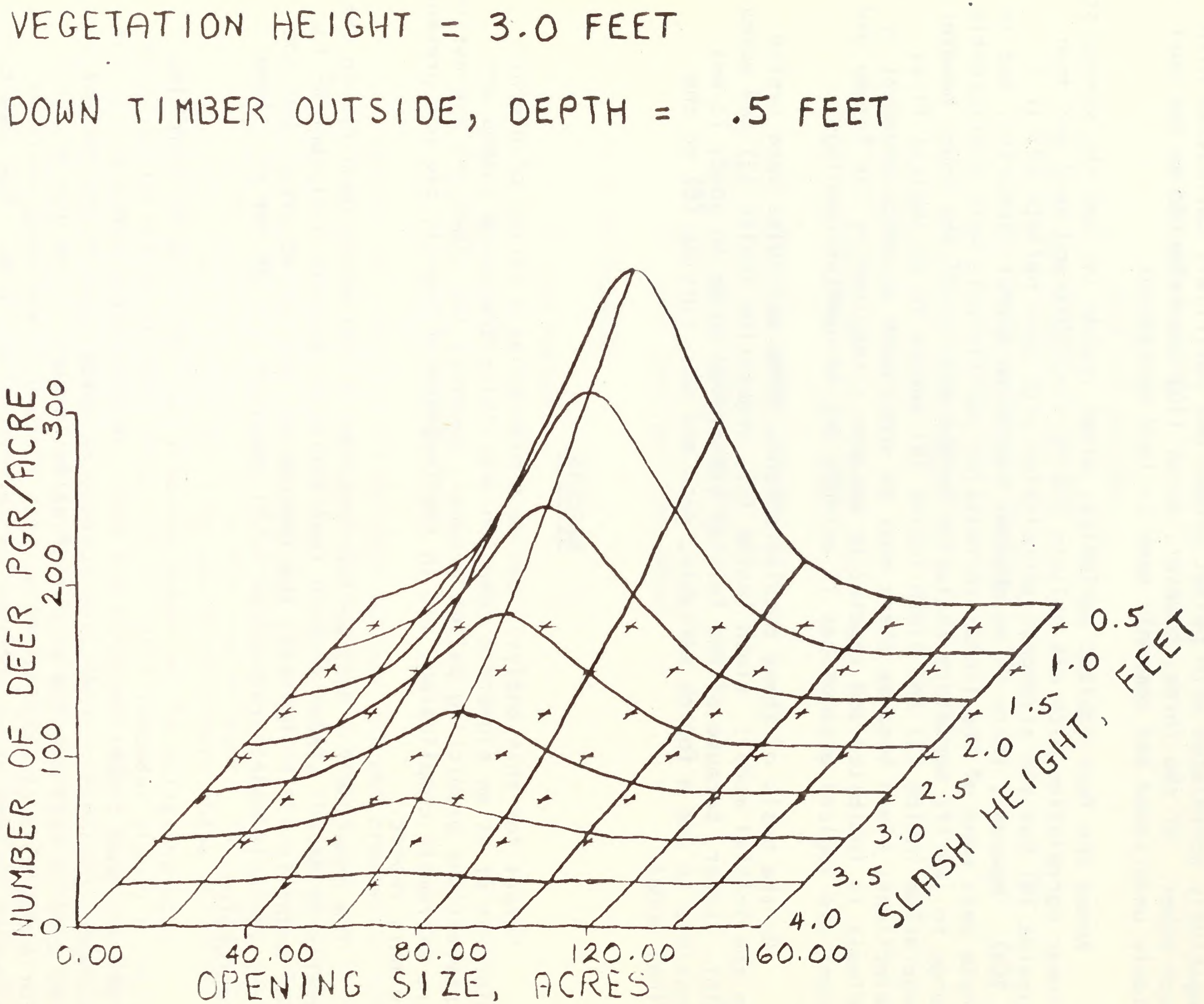


FIGURE 1. Prediction surface for deer pellet groups

In order to examine the effects of a change in vegetation height or a different down timber depth another submodel is required. For the original output, vegetation height submodels at one foot intervals to five feet and down timber submodels at half-foot intervals to 2 1/2 feet were displayed. The complete array includes 25 different submodels. However, for both deer and elk, the submodels for 2 1/2 feet of dead and down timber are identical to submodels for 2 feet. Thus, a display of 20 is considered adequate.

In the following discussions, results for deer are presented first. Although, the study of deer is considered only peripheral to the main objectives of the Montana Cooperative investigation, the results for deer are more straight forward and provide a background which makes explanation of the elk behavior patterns somewhat easier.

Deer use of clearcuts

Figure 2 presents 20 submodels projecting deer use of clearcuts. The array can be interpreted with vegetation increasing on columns to the right and down timber increasing on rows toward the bottom.

Interpretation

Throughout the displays presented here, pellet distributions demonstrate a consistent deer preference for openings in the 60 a. size class. Use of such openings, however, is dependent on the amount of vegetation and slash in the opening and is controlled by access limitations presented by down timber in the uncut forest. The following summary points are apparent:

1. Dead and down timber exceeding 2.0 feet in the uncut forest will so limit deer distribution that the presence of clearcuts is probably irrelevant to deer populations.

2. Where dead and down timber is not limiting, the preferred opening size is about 60 a. and the acceptable range is probably 40 to 80 a.

3. Deer use of any opening with vegeation height under 1.0 feet is limited, but use increases with 2.0 feet of vegetation and peaks at 3.0 feet. Additional increments of vegetation height produce only a minor increase in the range of acceptable openings to possibly 20 to 100 a.

4. Within any acceptable opening, slash in excess of 2.0 feet will reduce deer use by at least 50 percent.

At this point, no attempt has been made to separate deer by species although both white-tailed and mule deer were involved in the sample. It can, however, be pointed out that 71 percent of the variation in the sample data has already been explained. Thus, the possibility of achieving better predictions in the basis of species behavior involves less than 30 percent of the known variation.

Elk use of clearcuts

Figure 3 presents the 20 submodels projecting elk use of clearcuts. The array can be interpreted with vegetation increasing on columns to the right and down timber increasing on rows toward the bottom.

Interpretation

Elk use of clearcut openings presents a considerably different picture than deer use in several respects. Elk, for example, are not limited in their distribution by dead and down timber in the uncut forest, but the down timber does have a significant influence on elk preference for size of opening. The following summary points are notable:

1. Elk preferences for any specific size opening are much less definitive then the preferences shown by deer. The acceptable range of tolerance declines from 20 to 100 a. Where no down timber is present in the uncut forest to less than 20 a. where dead and down is 2.5 feet deep.

2. Elk use of any opening with vegetation less than 1.0 feet tall is limited, but use of larger openings increases with increasing vegetation height to at least 5.0 feet. Use of smaller openings is unaffected by vegetation height.

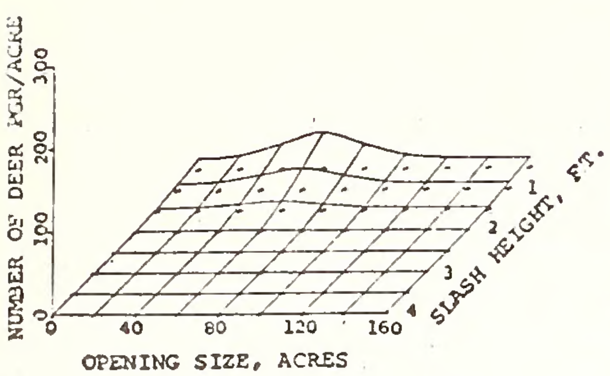
3. Within any acceptable opening, slash in excess of 1.5 feet will reduce elk use by at least 50 percent.

CONCLUSIONS

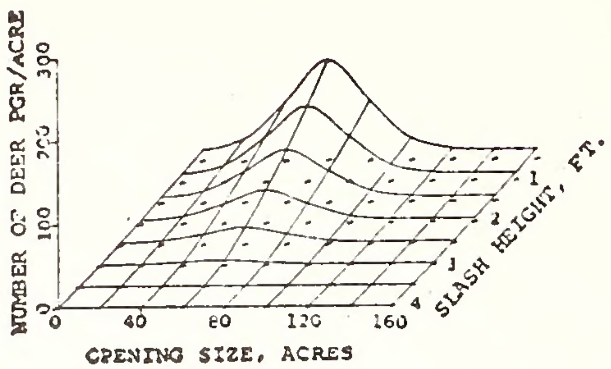
Results presented in this report are considered preliminary, but there is no question that certain implications in forest management are indicated. First, it is significant that deer and elk cannot be broadly treated as unspecified "big game." The behavioral patterns demonstrated here are so different that cutting patterns must be tailored to the objective desired.

Second, the indicated preference for opening size should not be misinterpreted to indicate benefit. The fact that elk use of larger openings continues to increase with vegetation height may, in fact, indicate a preference for the uncut forest. Hopefully, this point can be clarified in other studies.

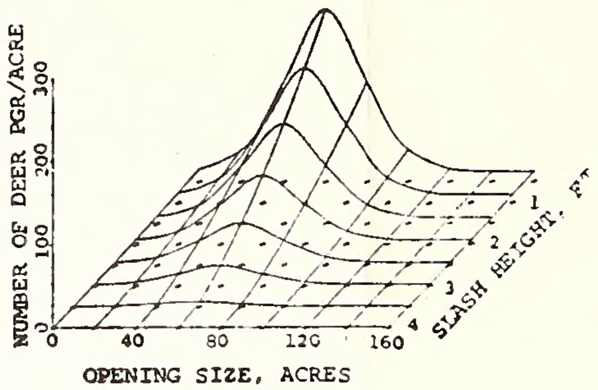
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



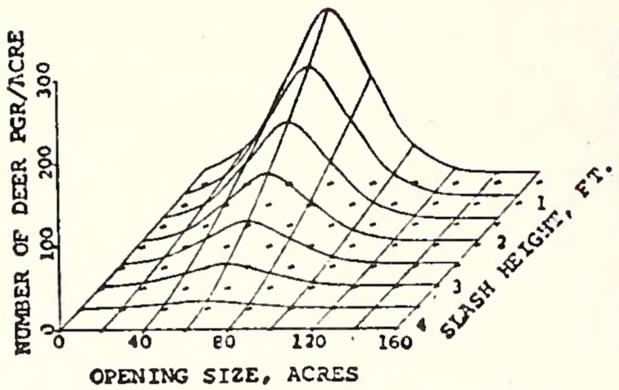
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



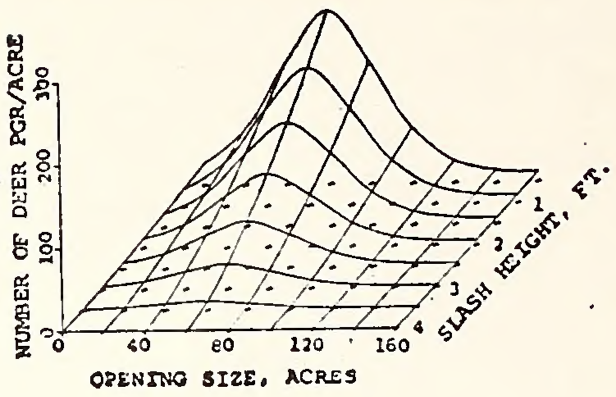
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



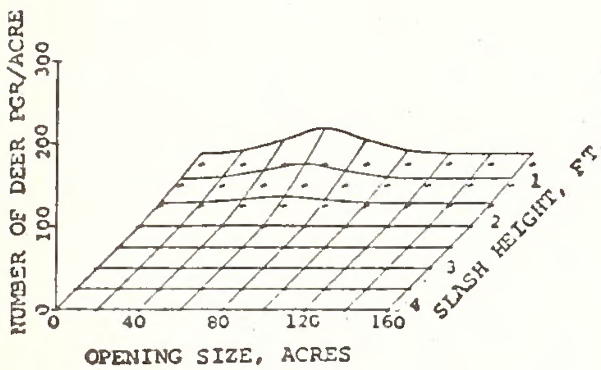
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



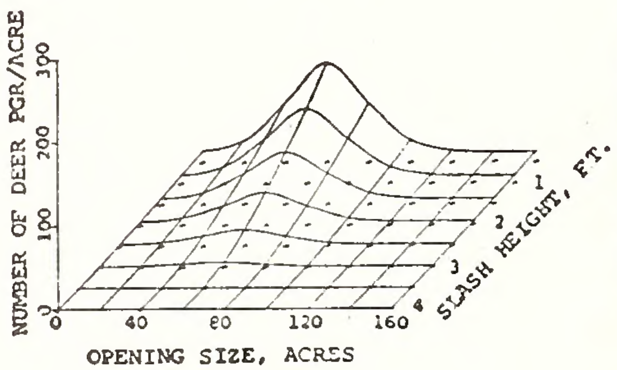
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



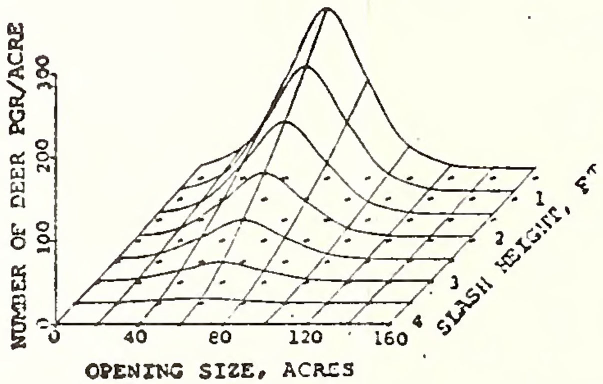
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



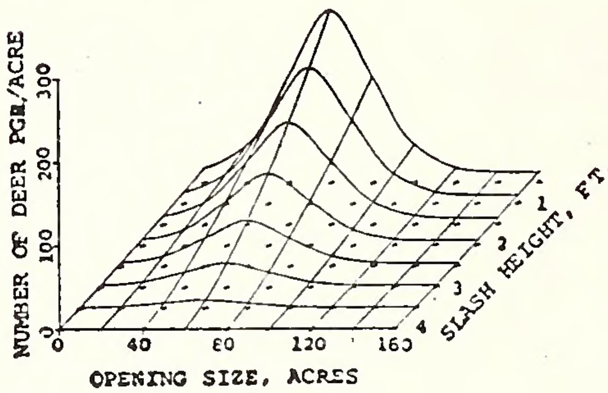
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



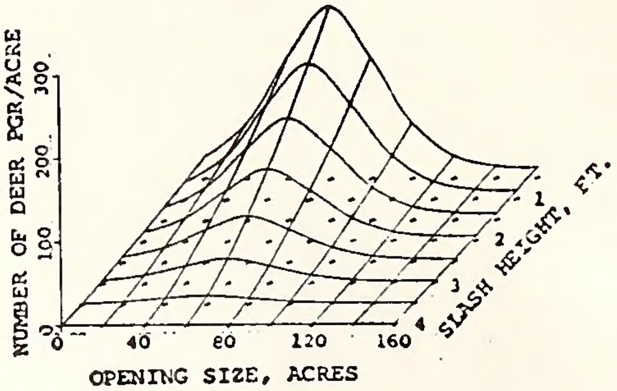
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



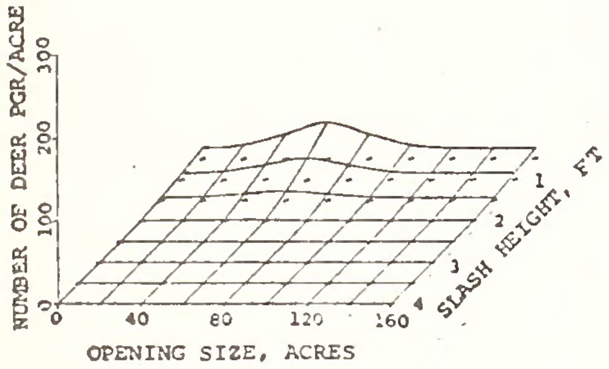
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



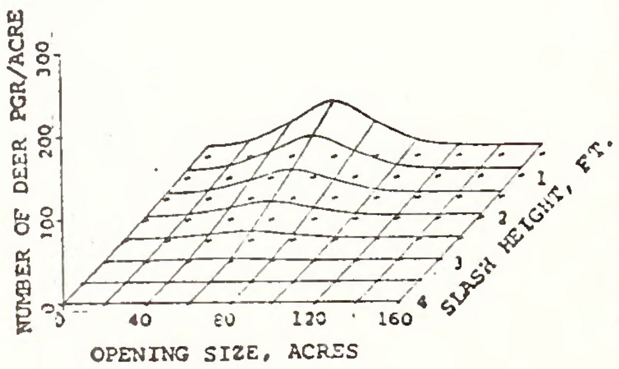
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



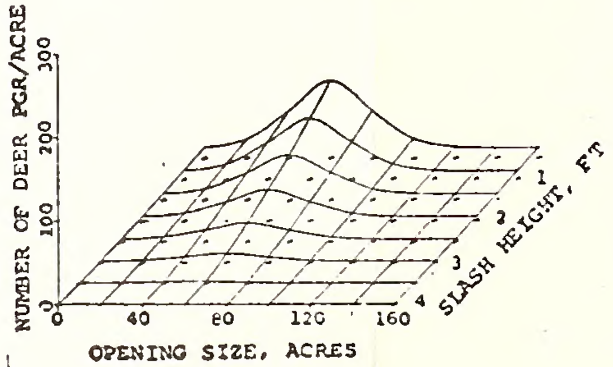
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



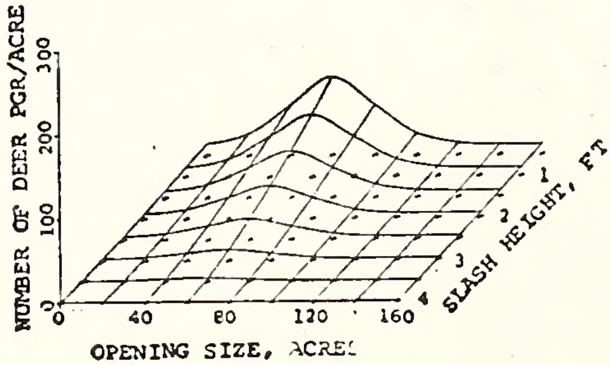
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



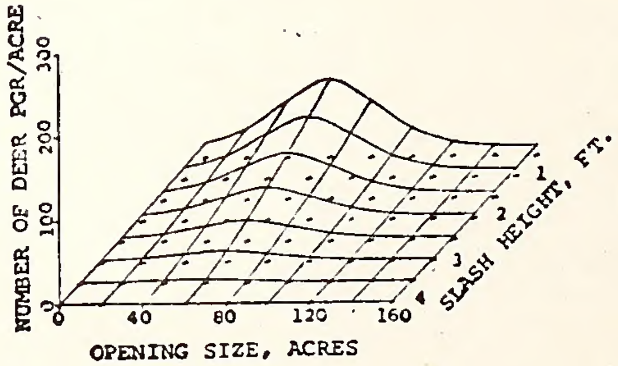
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



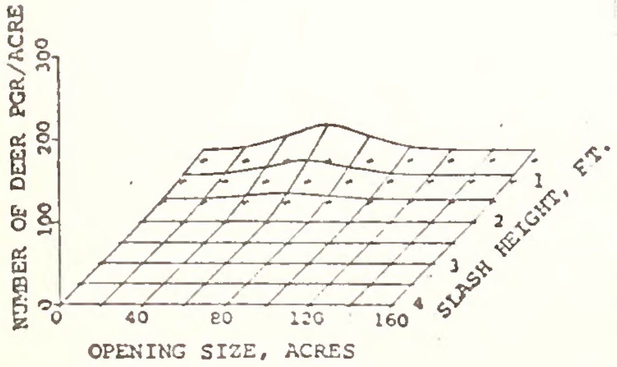
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



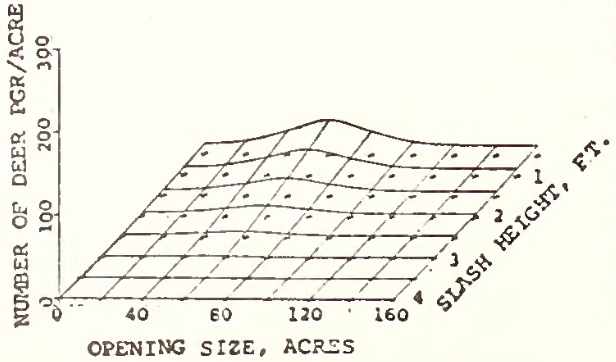
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



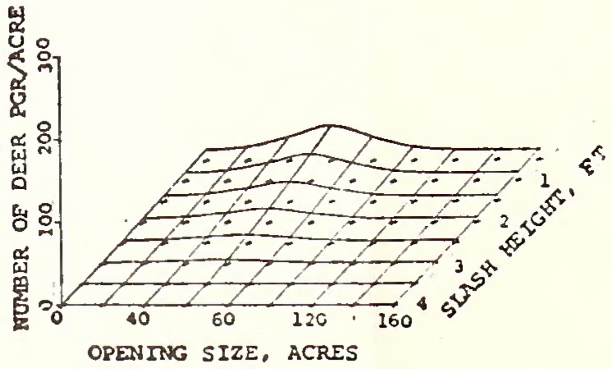
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



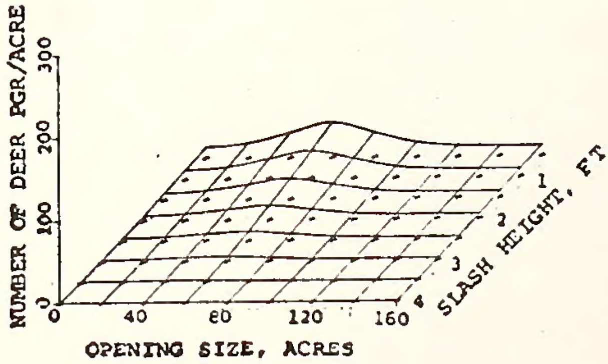
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



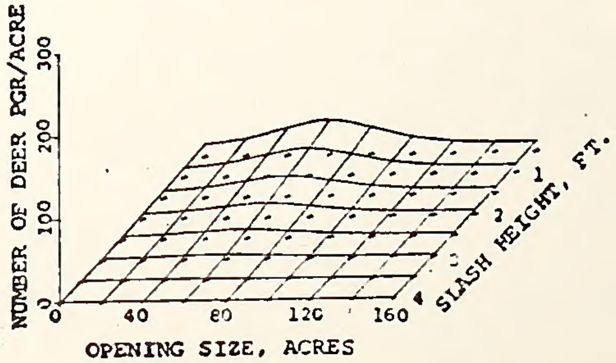
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



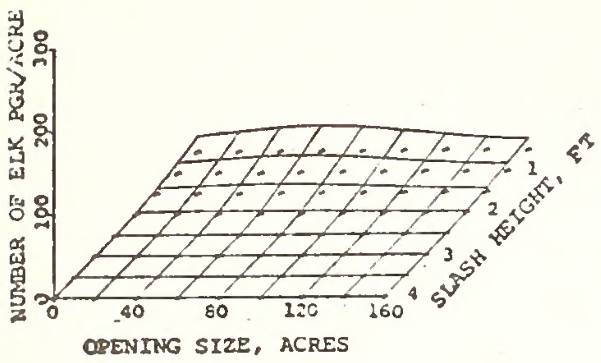
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



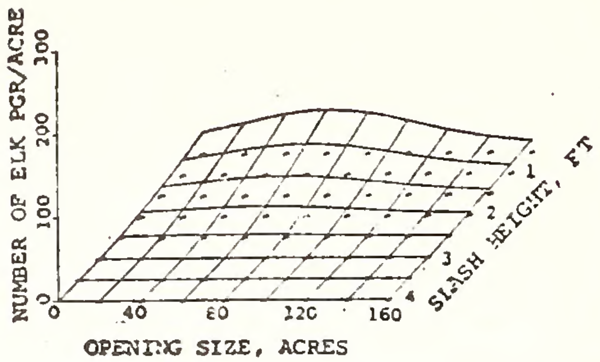
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



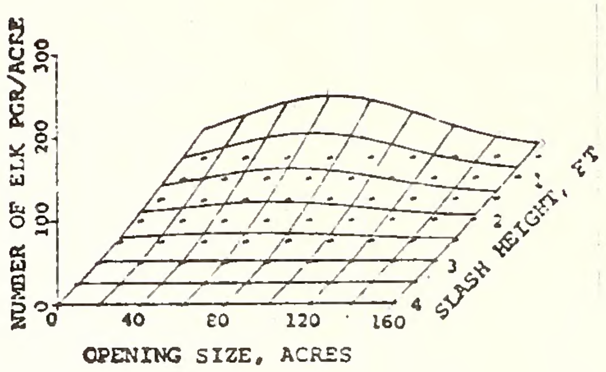
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



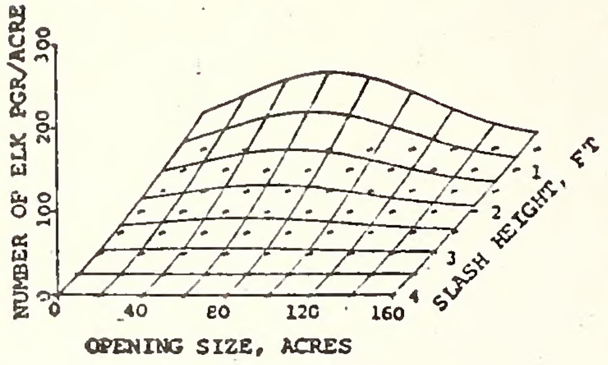
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



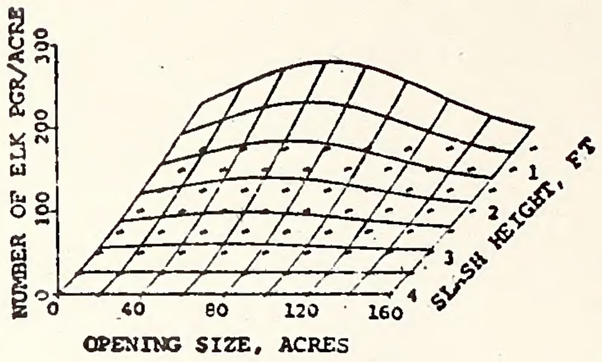
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



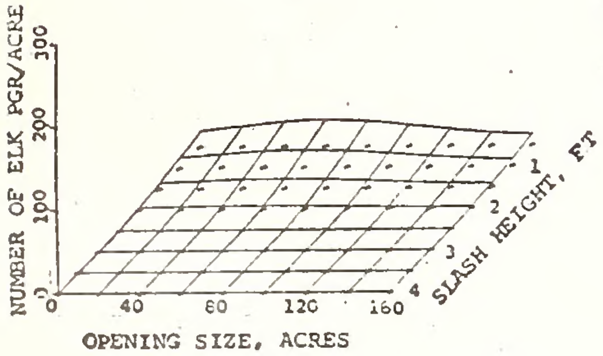
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



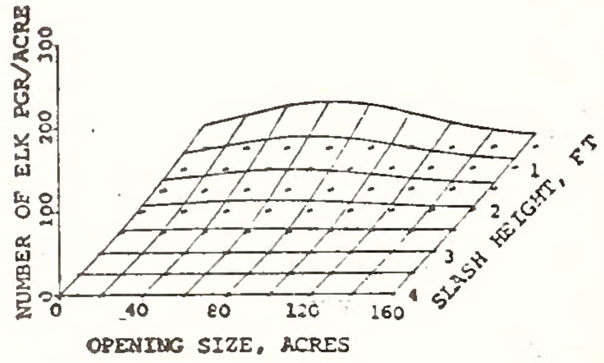
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 0.5 FEET



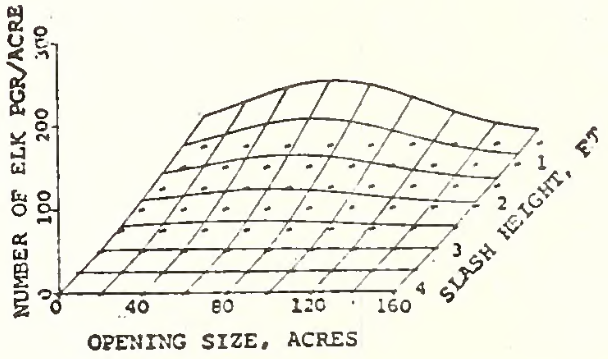
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



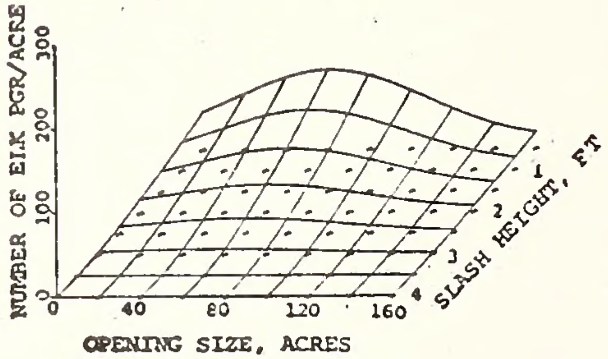
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



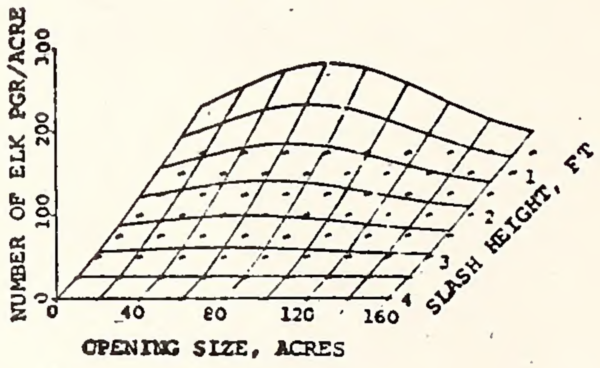
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



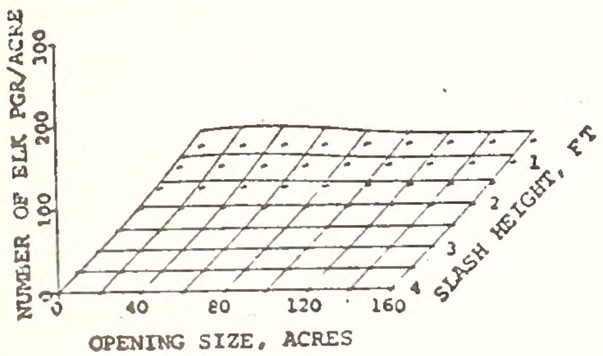
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



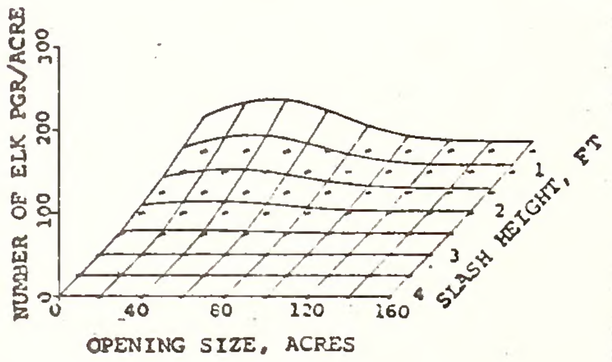
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.0 FEET



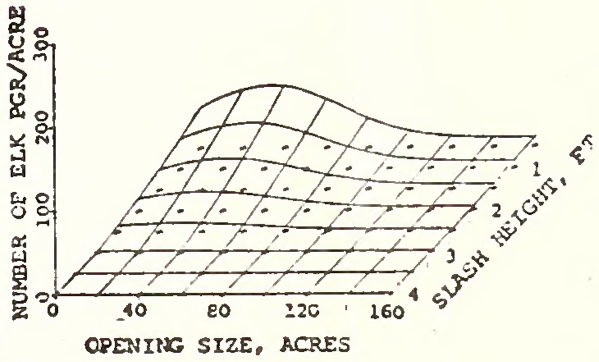
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



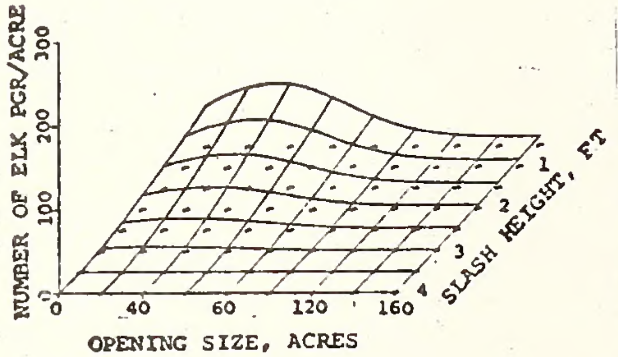
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



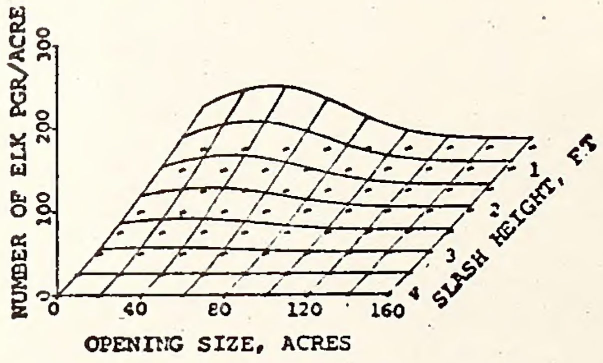
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



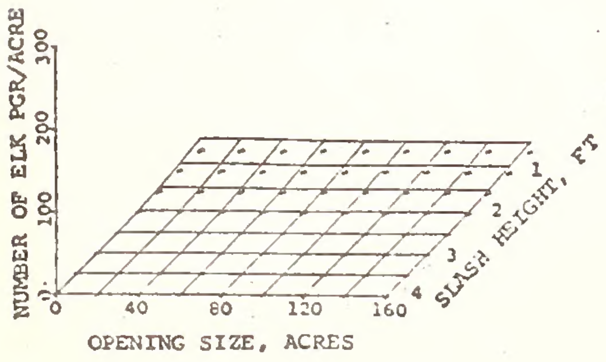
VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



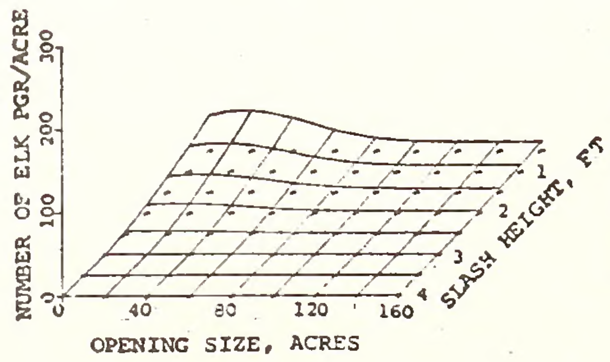
VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 1.5 FEET



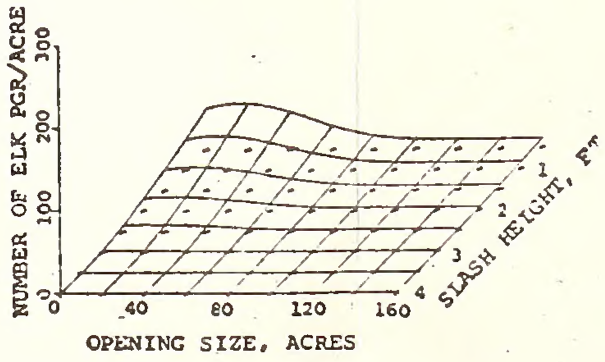
VEGETATION HEIGHT = 1.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



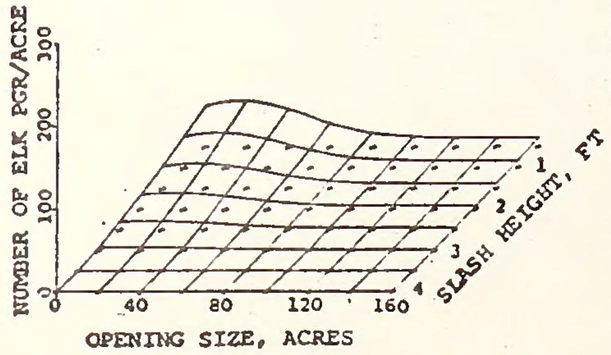
VEGETATION HEIGHT = 2.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



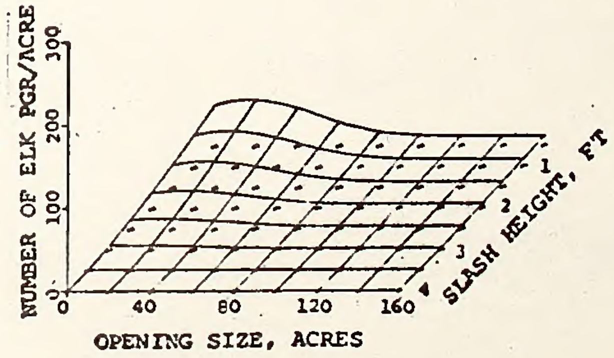
VEGETATION HEIGHT = 3.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



VEGETATION HEIGHT = 4.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



VEGETATION HEIGHT = 5.0 FEET
DOWN TIMBER OUTSIDE, DEPTH = 2.0 FEET



Third, although logging disturbances and vehicle access are simply hidden away in the unexplained variance of this model, other research of the Montana Cooperative Study has demonstrated a considerable effect on elk behavior. Thus, consideration of the recommendations already made with regard to roads and timber sale activities will provide additional dimensions for valid management decisions.

Finally, the reader should recognize that this model is limited mathematically by the fact that the algebraic simulation was fitted to existing data and applies, in a statistical sense, only to that data. Prediction of future events on the basis of the model can pragmatically be considered objective because the model appears to be biologically sound; but extrapolation outside the western Montana study area should be viewed with skepticism. Additional samples from Eastern Montana clearcuts will be obtained during the summer of 1975.

LITERATURE CITED

Jensen, Chester E. and Jack W. Homeyer

1970. Matchacurve - 1 for algebraic transformations to describe segmoid- or bell-shaped curves. USDA Forest Service, Intermtn. For. and Range Exp. Station, Ogden, Utah 84401 22 pp., illus.

1971. Matchacurve-2 for algebraic transforms to describe curves of the class X. USDA Forest Service, Res. Pap, INT-106, 39 pp., illus.

Jensen, Chester E.

1973. Matchacurve-3: multiple - component and multidimensional mathematical models for natural resource studies. USDA Forest Service Res. Pap. INT-146, 42 pp., illus.

Submitted By: L. Jack Lyon

SURVEY OF BIG GAME USE OF TIMBER HARVEST OPENINGS

PELLET-GROUP SAMPLING INSTRUCTIONS

Data collection for this study requires six steps. These are keyed to titles on the data sheets. The first four steps can probably be completed in the office while the last two describe collection of field data. In order to obtain standardization in sampling, please use the following definitions:

Timber Harvest Opening--The total opening to be sampled. It may consist of one to several cutting units, but it must be surrounded by unlogged vegetation.

Cutting Unit--A timber harvest block or stand which has received the same treatment over the whole area and is essentially confined to a single aspect. Do not be overly precise in separating units on the basis of aspect changes as long as cutting method and slash treatment are consistent within the unit.

Pellet Group--Pellets numbering up to 30 should be considered a single group if they appear to be about the same shape, size, color and age and have not spread more than 5-6 feet. However, a single pellet should also be counted as a group if no other pellets are in evidence. Where a pellet group is partially in and partially out of the sample plot, attempt to determine the center of the group and record it only if the center is inside the plot. Deer and elk pellets can be differentiated on the basis of size--length over 3/4" and diameter over 1/2" is usually elk.

Please follow these instructions closely and complete all entries at appropriate places on the data sheets. The numbered lines along the right hand margins are for ADP coding and can be ignored.

1. LOCATION AND SIZE OF TIMBER HARVEST OPENING (page 1). On an aerial photograph, measure the perimeter of the forest opening to be sampled. Use a map measurer or a piece of string to determine the length of the edge. The area (in acres) may be available from some other source. If not, a planimeter or dot-grid estimate of acreage should be obtained. In a few areas you may encounter situations with adjacent clearcuts and selection cuts covering such a large area that it is virtually impossible to define a harvest opening entirely surrounded by unlogged vegetation. Where this occurs, the clearcut units may be treated as harvest openings and the selection units as uncut forest.

2. DESCRIPTIONS OF CUTTING UNITS (page 2). A diagram of a forest opening with two cutting units is presented on the last page of these instructions for assistance in following these directions.

a. Determine the number of cutting units within the timber harvest opening. Designate the units A, B, C, etc., and complete a separate data sheet (page 2) for each unit.

b. On the aerial photo, draw in the longest straight line which will pass through the cutting unit. This is the baseline. Designate the downhill end of this line as X, the uphill end as Y.

c. Determine the length of the baseline within the cutting unit. This length will determine whether one, three or five transects are required to sample the unit.

d. Draw in a line which passes through the center of the baseline at right angles. This is pellet-count Transect 1.

(1) If the baseline is less than 1,000 feet long, only one pellet transect is necessary.

(2) If the baseline is between 1,000 and 2,000 feet, draw in two additional pellet transects at right angles to the baseline and equidistant from the first transect and the cutting unit boundaries on each side. Number the transect nearest the X (downhill) end of the baseline 2 and the transect at the Y end of the baseline 3.

(3) If the baseline is over 2,000 feet, draw in four additional pellet transects, two on each side of the first transect at right angles to the baseline and equally spaced between the first transect and the cutting unit boundary. Number the transects 2 and 4 on the X end of the baseline, 3 and 5 on the Y end. Transects 4 and 5 should be those most distant from transect 1.

3. COVER ADJACENT TO CUTTING UNIT. On the aerial photo, extend the baseline and all pellet transects beyond the cutting unit edges for one-eighth mile. Designate the downhill end of each transect X and the uphill end Y to identify the extensions. For each extension, select an appropriate code to describe the kind of cover adjacent to the unit. When a projection is coded 3 or 5 (another cutting unit) determine the distance from the edge of the unit (i.e., the end of the transect) to the nearest uncut vegetation.

4. HISTORY OF CUTTING UNIT. Most of the information requested here is probably available in the timber sale documents. However, the answers should be checked against actual conditions on the ground.

5. DESCRIPTION OF CUTTING UNIT. Habitat type refers to the Daubenmire classifications currently in use in Region 1.[1] In the absence of adequate information, please list the major tree and understory species present in adjacent uncut stands.

6. PELLET COUNT DATA (page 3). Because of the variety of information requested, this data sheet is relatively complicated. Please follow these directions very carefully because the data will not be usable if improperly recorded.

a. Use a circular plot, 16 1/2 feet in radius (33 feet diameter = .02 acres). A light rope attached to a pin in the ground is convenient although we have found that plot size need not be measured except for those pellet groups which are found on or near the plot edge.

---

[1] Daubenmire, R. and Jean B. Daubenmire. 1968. Forest vegetation of eastern Washington and northern Idaho. Wash. State Univ. Exp. Sta. Tech. Bull. 60. 104 pp. and Pfister, Robert D., et al. 1972. Preliminary forest habitat types of western Montana. USDA Forest Service, INT and R-1. 80 p. (mimeo).

b. Cutting unit ID is the letter (A, B, C, etc.) designated in step 2.a. Transect numbers were assigned in step 2.d. Each transect number should be accompanied by an X or Y from step 3 (for example, Transect No. 2X), indicating the end of the transect at which the number 1 plot is located. In addition, the baseline should be sampled between the cutting unit edge and the point at which it crosses a numbered transect (show as Base X or Base Y on data sheet).

c. Sample one "edge" plot at the start of each transect. This plot should be located on the cutting unit boundary--half in the uncut. It may be established at either the X or Y end of the transect.

d. Plots within the cutting.

(1) On transects: from the center of the edge plot, measure 50 feet along the transect line to the center of Plot No. 1. Thereafter, measure 100 feet from plot 1 to plot 2 to plot 3, etc. until the other side of the cutting unit is reached. No edge plot is required on this end of the transect, and if the last plot actually overlaps the edge it should be moved back far enough to fall entirely within the cutting unit. If more than 29 plots are needed, continue on the back of the data sheet.

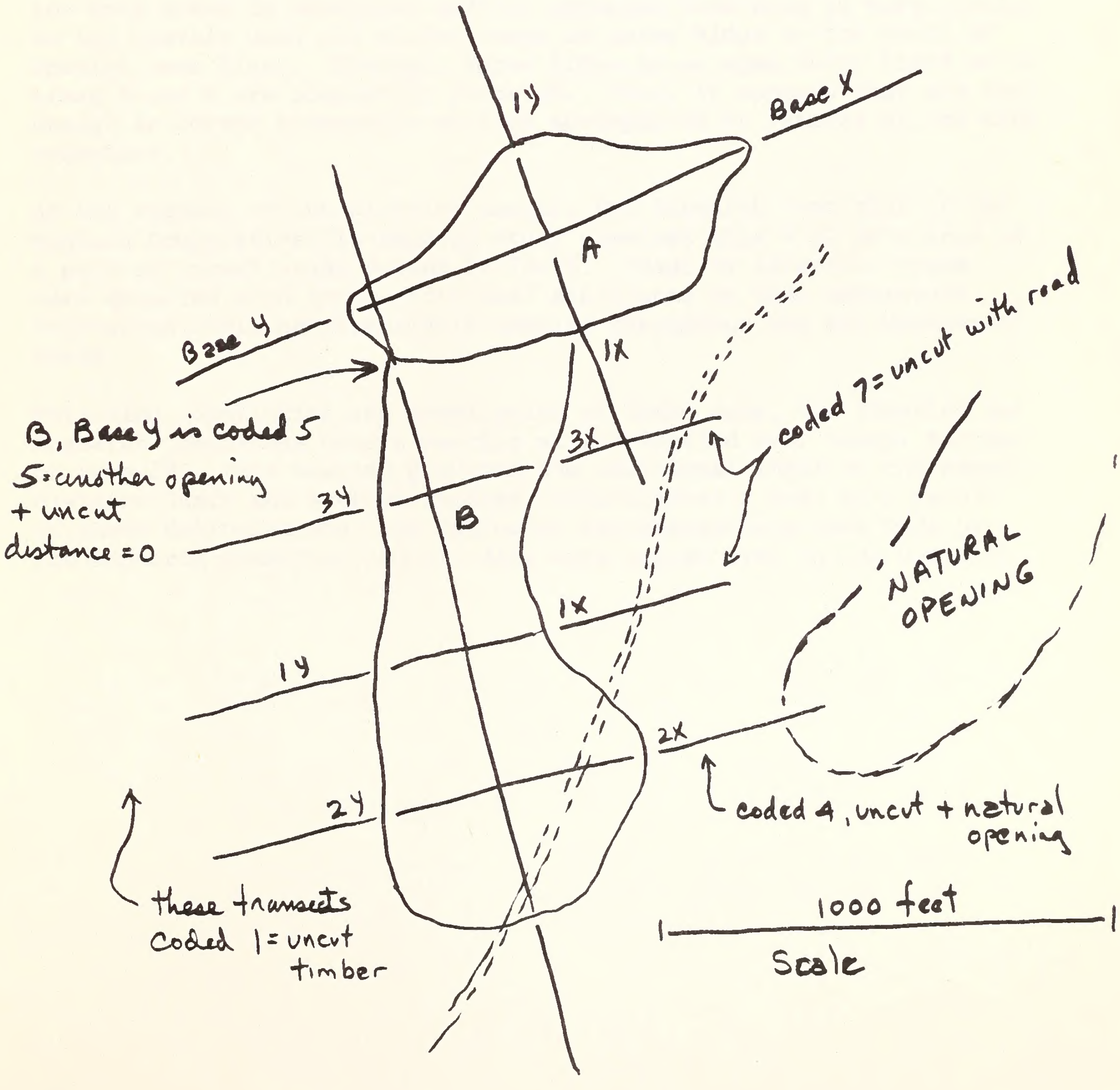
(2) On the baseline: from the center of the edge plot, measure 50 feet along the baseline to the center of Plot No. 1. Thereafter, measure 100 feet from plot 1 to plot 2 to plot 3, etc. until a numbered transect is crossed. This is the end point for the baseline sample.

e. Plots outside the cutting unit on both numbered transects and baselines: from the center of the edge plot, measure 50 feet into the uncut forest to find the center of Plot No. X1 or Y1 (record uncut plot data on right hand side of data sheet). Thereafter, measure 100 feet along the transect extension from plot 1 to plot 2, etc. to plot 5. Plot No. 1 on the end of the transect (Y1 or X1) is located by simply continuing the 100-foot interval from the last plot within the cutting unit. In those cases where this plot overlaps the cutting unit boundary it should be moved forward far enough to fall entirely in the uncut forest. In those cases where the end of a transect continues into another cutting unit, the edge plot and X or Y plots need not be taken.

f. Data recorded in cutting unit plots: in addition to the number of pellet groups per plot, record the height of vegetation and the height of slash to the nearest foot. Where this is not consistent over the whole plot, make an estimate for each quadrant within the plot and record the average.

g. Data recorded in the uncut plots: in addition to the number of pellet groups per plot, record an estimated cover value and a depth for dead and down timber. Cover value is a subjective rating on a scale of three. Most uncut forest will rate 2. However, if you feel that an animal standing in the center of the sample plot is quite visible (as in a thin lodgepole pine stand with a beargrass understory or in a fair-sized natural opening) rate the cover 1. If, on the other hand, the cover is quite dense (as in a thicket of spruce reproduction or a clump of taller shrubs) rate the cover 3. Depth of dead and down timber is estimated the same way slash depths were estimated.

h. Some of the plots located in this study will fall on roads. Whenever a plot does include a part of a road surface, cut, or fill place a checkmark by the plot number on the data sheet. Roads should be checked whether or not they are still open to traffic.


1Y
Base X
A
Base Y
1X
3X
3Y
B
1X
1Y
2X
2Y
NATURAL OPENING
1000 feet
Scale

B, Base Y is coded 5
5 = another opening + uncut
distance = 0

coded 7 = uncut with road

coded 4, uncut + natural opening

these transects Coded 1 = uncut timber

JOB IV

Spotted Bear Study

Introduction

The Spotted Bear Ranger District of the Flathead National Forest has designated Management Areas A and B (see Multiple Use Plan for the Spotted Bear Planning Unit for details) for management:

> "...to provide the optimum balance of forage and cover needed for quality winter habitat for elk."

Management Areas A and B are roadless units adjacent to the South Fork of the Flathead River south of Spotted Bear River. The general aspect for both areas is southwest and the apparent land form is very similar to the heavily used elk winter range on Horse Ridge to the north of Spotted Bear River. However, Horse Ridge is an open shrub field while Areas A and B are completely forested. Thus, it appears that any real change in forage production must be accompanied by removal of the tree overstory.

At the request of the District Ranger, the Research Committee of the Montana Cooperative Elk-Logging Study examined this 6700 acre area as a part of formal study during FY 74-75. Stage II inventory crews were enhanced with three additional assistants so that understory vegetation could be intensively sampled throughout the two Management Areas.

Following compilation and examination of these data, the Steering and Research Committees held a meeting at the Spotted Bear Ranger Station on June 18. This meeting provided the additional input of the Ranger District Staff and several student investigators. And, as a result of these deliberations, the following recommendations were made by the Research Committee and all data were turned over to the District.

SPOTTED BEAR RECOMMENDATIONS
RESEARCH COMMITTEE OF THE MONTANA COOPERATIVE ELK-LOGGING STUDY

Following the meeting at Spotted Bear on June 18, 1975, the Research Committee of the Montana Cooperative Elk-Logging Study made some revision of the tentative recommendations and now proposes the following guidelines. We recognize, however, that there are some questions, particularly with reference to snowfall patterns and wind that remain unresolved. Our first and strongest recommendation, then, is that the initial cutting operation be carefully evaluated to determine:

1. elk distribution changes as a result of cutting.
2. elk preference for various cutting patterns.
3. forage production changes associated with cutting.
4. the ways in which cuttings effect snow distribution, depth, and crusting.

Access and Timing

The first general area of consideration in the proposed development involves questions of road construction, timing of timber sales, and effects of logging disturbances on elk. As background for these recommendations, the following assumptions have been made:

1. No balloon or helicopter logging will be possible in the first sale. Access will be confined to roads coming in from the Spotted Bear Ranger Station and terminating at Harrison Creek.
2. Pellet counts conducted during the summer of 1974 show a considerable use of alpine fir habitat types in the Spotted Bear unit. This has been interpreted as summer use and justifies the assumption that effort should be made to limit the amount of disturbance and provide security for elk using the unit during the summer.
3. Winter range created by any vegetation disturbance on the Spotted Bear unit will not come into production for at least 2 years, will probably not reach maximum until about the eighth year following disturbance, and may begin to decline in production after 15 to 20 years.

Given these assumptions, we recommend:

1. The system road required to provide access for management should be constructed during the initial timber sale. This will:

    a. confine the disturbance to a single time period, and

    b. allow the winter range development to be spread out over the whole unit.

2. In the degree possible, road construction should be confined to a single main road and this road should be permanently closed to all nontimber sale traffic.

3. The main access road should be designed at or below the minimum standard acceptable to traffic engineers. We suggest single lane, 10 feet with enforced speed limit of 10 mi/h.

    a. Cuts and fills reduced to absolute minimum.

    b. Slash cleanup to leave no barriers over 2 feet deep, 5 feet wide, or 50 feet long.

4. Summer range security should be a consideration in cutting unit design. However, we doubt that an uncut strip of timber along the lower edge of the unit near the river will be adequate, and it seems apparent that an uncut strip at the upper elevation of the unit is not possible because of already existing natural openings. Nevertheless, the cutting layout should be planned so animals can move from Harrison Creek to Spotted Bear Lake without ever crossing an opening.

5. Timber harvest to occur at 15-year intervals. This interval was selected on the logic that 5-years (minimum) to plan, mark, and complete a sale would result in almost continuous disturbance for any shorter cutting interval. The initial sale should be designed to harvest a somewhat greater proportion of the allowable cut than subsequent sales because:

    a. the objective is to create winter range where none exists now,

    b. a somewhat greater harvest may be required to justify road construction, and

    c. future sales may require some sacrifice in the total allowable cut, but the degree of reduction should be based on flexibility provided by the first cut.

6. The timber sale disturbance should be confined to the period preceding October 1 in any year and should require no more than 2 years including postsale cleanup. At the completion of the sale, the main access road should be closed.

7. In consideration of the relatively narrow area of timber above Spotted Bear Lake and the known elk movement through this timber corridor to the Spotted Bear River drainage, we do not believe the proposed road should be constructed. Even the most careful road design will have adverse effect on elk in this area.

Cutting Patterns

In suggesting the kinds of cuttings to be made, the research committee again had to make a number of assumptions.

1. The Spotted Bear unit cannot be directly compared with existing winter range on Horse Ridge, and it may be unrealistic to assume that winter range conditions on Horse Ridge can be duplicated. In any case, we assume that snow management should be a significant consideration in the design of cuttings. Two students working in this area for the past two winters have compiled some observations which, unfortunately, do not demonstrate a consistent pattern.

   Simmons (1974) thesis contains a number of observations which seem important:

   a. aspects between 150 to 270° have the least snow

   b. aspects between 300 to 90° have the most snow

   c. upper slopes and ridgetops have deeper snow

   d. wind on steep slope openings will clear snow

   e. shrubs accumulate more snow than grass

   f. Douglas-fir accumulates less snow than alpine fir

   g. southeast aspects accumulate less snow than northeast aspects

Dean Biggins, on the other hand, has worked the area in a winter in which the wind did not blow. As a result, he suggests:

  a. snow depths are lower in the forest than in openings by 25 to 30 percent

  b. wind had almost no influence in clearing areas of snow

  c. crusting caused by rain was a major problem in openings and in the timber

  d. one of the favored areas for elk was the "snow well" at the base of very large trees

2. The best opportunities for creation of productive winter range exist in those areas that already have an existing shrub understory. The obvious exceptions are situations where ceanothus is present even though there are few other shrubs.

3. Clearcuts, where they are used, should be designed with snow load and windsweep in mind. To this end, we suggest that openings larger than 10 acres and no larger than 40 acres are preferred.

4. When areas are selected as potentially viable winter range, it is important to consider adjacent areas which might be utilized by elk for cover and as access to the forage unit.

5. Development can be spread out into three distinct and separated areas so that:

   a. some degree of summer security and control areas for evaluation will be available between areas

   b. winter range development will be spread over the whole Spotted Bear Unit

   c. each area can be used as a distinct replication of the basic experiment--thus randomizing inherent differences in elk distribution

   d. the importance of spring range can be separated from winter range if a real difference exists because of snowmelt patterns in the Spotted Bear Unit

6. The Meadow Creek area, beyond Harrison Creek, will not become a viable timber harvest unit (by helicopter) for a long time.

Given these assumptions, we recommend:

1. Select three general areas for development as winter range. Areas to be spaced at about one-third intervals along the Spotted Bear unit with undisturbed areas between.

    a. Each of the three areas should contain at least one example of the three kinds of cutting units recommended in item 3 below. This will allow evaluation of elk use and effects on snow in each of the three replicated areas.

    b. Undisturbed areas between the developed areas will provide control for evaluation for elk use.

2. Plan for three kinds of cutting units in each general area of development. In our descriptions we have purposely avoided silvicultural terminology because we are interested in end result and because silvicultural method is the prerogative of the man on the ground. We do, however, propose the following criteria for cutting units:

    a. select areas for winter range production

        (1) on aspects between 150 and 270°

        (2) with an existing shrub community.

    b. leave uncut timber between cutting units sufficient that visibility is blocked.

    c. select an adjacent cover area of uncut timber

        (1) of the same size or larger than the cutting unit

        (2) southeast preferred over northeast

        (3) Douglas-fir habitat types preferred.

3. Design cutting units to produce one of the three following results:

    a. Graded canopy openings ranging from no trees on the upwind end through increasingly dense canopy to uncut timber at the downwind end. Cut blocks should fairly large (30 acres) and leave trees should include several per acre in large diameter classes.

    b. Partial canopy openings ranging from 25 percent tree crown in the selected high production forage area to 50 percent or more in the remainder of the cutting unit. This might be compared to a seed tree cut surrounded by shelterwood. Again, leave trees should include several per acre in large diameter class.

    c. Clearcuts of several sizes, up to 40 acres. Locations selected for this treatment should be designed to obtain all possible wind sweep to clear snow.

4. For any one or all of the above alternatives, it may be possible to put in an upwind strip clearcut designed to drop windblown snow before it arrives at the selected forage production area.

5. Silvicultural necessity may require some deviation from the following suggestions, but we recommend:

    a. about 50 percent of the treated area in each replication by alternative a (graded canopy) and 25 percent by each of the remaining alternatives (b. partial canopy, c. clearcut).

    b. Fire should be used in as many cutting units as possible. Even the partial canopies would benefit from a groundfire treatment.

6. Since timber harvest will not be possible beyond Harrison Creek for a number of years, we recommend creation of some openings in that area with prescribed fire.

7. Long-term management should assume a high degree of flexibility. The initial cutting should assume virtually no sacrifice of eventual timber yield from the Spotted Bear unit. However, where treatments applied prove to be successful, future treatment should be applied to prevent tree invasion and prolong forage production.

Evaluation

We consider evaluation of results so important that we again reiterate the recommendation on page 1. The reasons for this emphasis seem obvious, but it's worth noting that the design of all future timber sales and any proposed investments in direct wildlife habitat treatment will be determined by results of the initial cuttings. With regard to this evaluation, however, the Flathead National Forest and the Spotted Bear District both have biologists; and we see no need to design the required study. In the degree that we can be of assistance, however, all members of the Research Committee are available for consultation and review of proposed plans.

Submitted by: Research Committee

APPENDIX

APPENDIX I

During the report period two M.S. theses and one Ph.D. thesis were completed for jobs associated with the elk-logging study; following are their abstracts or summaries:

Beall, R. C. June 1974. Winter habitat selection and use by a western Montana elk herd. Ph.D. thesis, Univ. of Montana, Missoula. 197pp.

ABSTRACT

Winter habitat selection and use by a western Montana Rocky Mountain elk herd was evaluated over three years, from June 1969 to March 1973. Objectives were to evaluate habitat selection and use in terms of activities, ambient meteorological and radiation conditions, and seasonal changes. Habitat types and elk activity areas were instrumented with recording thermographs, hygrothermographs, microbarographs, anemometers, snow courses, and portable net radiometers. A base meteorological station, on site, was equipped with a Beckman-Whitley hemispherical radiometer, a Soumi-Kuhn ventilated net radiometer, and temperature sensing devices.

Movements and habitat use were affected by snow, meteorological conditions and radiation conditions. Snow depths were appreciably different in each of the three winters of study. Elk occupied elevations with less than 18 inches of snow. High elevations were used during years of light snow, and low elevations during heavy snow years. Other components of habitat selection remained the same at the various elevations.

Elk react to changing ambient air temperature and solar and thermal radiation conditions by selecting bedding sites which enhance control of body temperature. Eighty-six percent of elk bed sites evaluated were associated with timber clumps on the upper one-third of a slope. In colder periods, elk tended to bed on the south side of the stands during the day, and the north side at night. In warmer periods, elk bedded on the north side of timber clumps during the day, and the south side at night (r = .782 and .611). As temperature increased, elk beds shifted from south slopes to north slopes during the day (r = .953) and from north slopes to south slopes at night (r = .701); also, the number of trees per acre selected as day bed sites increased (r = .933), and the number of trees per acre at night bed sites decreased (r = .651). In all cases of habitat selection under varying meteorological conditions a closer correlation was found with thermal and solar radiation intensities than with ambient air temperature. Elk responded to varying temperatures and wind velocity combinations by seeking shelter when the wind chill factor approached minus 25°F. Elk sought shelter under all temperatures when wind velocity exceeded 30 mph.

Logging activity caused an initial avoidance response by elk. They then appeared to become conditioned to it and resumed normal activity after about two weeks. However, the altering of elk habitat creates an adverse ecological situation which is avoided by elk. Areas logged on the study area received light to medium use in winters prior to logging, and no use the winter following logging.

Bohne, J. R. July 1974. Food habits, seasonal distribution, and habitat utilization of elk in the South Fork of Fish Creek, Lolo National Forest, Montana. M.S. thesis, Univ. of Montana, Missoula. 187pp.

SUMMARY

From July 1970 to May 1972, an elk study was conducted in the Petty and South Fork of Fish Creek drainages in the Bitterroot Mountains of western Montana prior to logging of summer and fall ranges. The study area is a mosaic of old burns, dense stands of young conifers, and mixed remnant stands of mature ponderosa pine, Douglas fir, and western larch. The present elk winter range was created by major forest fires in 1910 and 1917. Mining, grazing, hunting, and recreation were the major activities in the area prior to 1950. Since 1950, logging and recreation were the major activities.

Elk used a winter range, summer range, and spring-late fall transitional range. Calving occurred on upper portions of the winter range and on transitional range. Movements from the winter range were influenced by green-up of grasses and forbs at higher elevations. Fall movements to the winter range were influenced by deep snow on summer and transitional ranges. Elk were found on southeast- to west-facing aspects at 4,300 to 5,000 feet during winter. During spring and summer, elk shifted to higher elevations and dispersed over all aspects. Use of north and west aspects was greatest during the rut and hunting season.

Open cover types were used during winter and spring. As summer progressed, elk used timber during the day and clearings at night. Use of timbered cover types was greatest during rutting and hunting seasons.

During winter, habitat types receiving heaviest use by elk were Douglas fir/bluebunch wheatgrass, Douglas fir/elk sedge, Douglas fir/snowberry, and Douglas fir/ninebark. In spring, use decreased on the Doublas fir/bluebunch wheatgrass and Douglas fir/elk sedge types and increased on the Douglas fir/beargrass type. Most observations of elk during summer and fall were made in the Douglas fir/beargrass and Douglas fir/ninebark types.

The wintering population contained approximately 250 animals. Pre-hunting ratios were 46 bulls:100 cows:46 calves in 1971. Harvest ratios were 128 bulls:100 cows:20 calves in 1970 and 164 bulls:100 cows:20 calves in 1971. The post-hunting season ratios were 17 bulls:100 cows:36 calves in 1970-1971 and 20 bulls:100 cows:20 calves in 1971-1972.

Food habits were determined from feeding site examinations and rumen analyses. Grasses and sedges made up 94 percent and forbs 6 percent of the spring diet. During summer, the diet consisted of 4 percent grasses and sedges, 16 percent forbs, and 80 percent browse. The fall diet consisted of 56 percent grasses and sedges, 13 percent forbs, 27 percent browse and 4 percent mushrooms. The winter diet consisted of 28 percent grasses and sedges, 7 percent forbs, and 63 percent browse.

The most important shrubs on the elk winter range in the Burdette Creek drainage were evergreen ceanothus, serviceberry, chokecherry, willow, and maple. Browse on the critical winter range was in fair to very poor condition. Use during the winter of 1971-1972 was moderate.

The limiting factor for the elk population was availability of escape cover during hunting season. Mortality from hunting was greatest when elk used open drainages after heavy snowfalls. Unroaded timbered areas used by elk during the rut and hunting season will be adversely affected by proposed timber sales. Based on available data, I recommend that:

1. Burdette and Lupine drainages not be roaded or logged, and proposed timber sales in adjacent drainages be broken down into smaller sales;

2. Adjacent large drainages be logged at least 10 years apart to allow for regeneration on the logged areas and give the animals time to "adjust" to changes in their habitat;

3. Road systems be kept to a minimum without interconnections, and some main system roads and most spur roads be closed when logging is completed.

Zahn, H. M. May 1974. Elk habitat and forage relationships in a timber-browse range in Western Montana. M.S. thesis, Univ. of Montana, Missoula. 71pp.

SUMMARY

During 1972-73, 11 elk were instrumented to obtain data on seasonal movements and habitat uses of the Burdette Creek elk herd in western Montana. All but one of the animals left the winter range area in summer. Distances moved from the winter range varied from 4.5 to 20 miles. Movements off the winter range occurred in a 2-week period from late May to early June. There was no evidence for preferred calving areas for the herd as a whole, although individual animals may calf in certain areas year after year. Summer-fall ranges varied from 2.8 to 35 square miles, being largest for bulls and cows without calves. During the summer-fall period, habitat types in the subalpine fir zone received heaviest use. Elk sightings were few in June and increased sharply for July when cow-calf groups of over 20 animals were frequently seen. Although fall ranges were nearly identical to those used during the summer, some instrumented cows displayed a shift to an adjacent area in early September. All surviving instrumented elk returned to the Burdette Creek winter range. Return movements were related to the first heavy snowstorm of the season and appeared to be gradual in contrast with spring dispersal movements which were sudden.

Bureau of Land Management
Library
Denver Service Center

Form 1279-3
(June 1984)

BORROWER'S

SK
417
.M85
1974

Montana Cooperative

DATE LOANED	BORROWER

USDI – BLM